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The Application of the Science of Genetics to the Farmers' Problems.*

JOHN W. GOWEN

Agricultural Experimental Station, Orono, Me.

The science of genetics was, I believe, rn at the time of the rediscovery of Mendel's inciples something less than a quarter of a ntury ago. This brief period is scarce- sufficient for the mortar in any ndation to set into permanent form. We e still engaged in the search for the funda- ntals. Yet how different are the methods breeding from those by which a like prob- n was approached before this advance was ade. The change has been so great that it uld be called revolutionary.

Mass Selection versus Progeny Performance Selection.

Thirty years ago at the experimental farms an agricultural experiment station in uthern Sweden a practical experiment was ade. This experiment had as its object e improving and distribution of seed of e common cereal grains so that these grains uld better fit the conditions of the coun- , producing larger returns and consequent- returning more money to the farmer. roughout, the work was carried on in a ictly practical manner; in fact in its ginnings the government did not finance e work; instead the practical farmers back the enterprise furnished the necessary nds.

Besides thorough scientific training the men t in charge of this work had extensive rming experience. They worked for a ries of years steadily with a large staff of sistants and plenty of land and every op- rtunity to bring the improvement in seed hich it was hoped would be produced. The ethod which was used in the attempt to ing about that improvement was one with hich you are all familiar. This method was, principle, simplicity itself. Let us take e case of oats for an example. In at- mpting to build up a strain of improved ts the method was at the beginning to test out a number of varieties, then to go through the fields, pick out the best heads, and in this way select enough seed for the next year's planting of the best of the first year's crop. This supposedly best seed selected in this way was all mixed together and planted the next year and again men went through the fields and selected what seemed to be the best seed, mixed it all together and planted it the next year and so on. This process of selecting what seemed to be the best on the basis of performance alone was continued for eight years. It would be reasonable to expect that within that length of time continued breeding for the best ought to have brought about a great deal of improvement. As a matter of fact the actual results obtained were quite different. There was no distinct and fixed improvement whatever as a result of this long continued selection in any grain, it made no difference which. All were practically alike in this respect.

At the end of these eight years the men who were doing this work called a halt and took account of stock of their method. The net result was to show clearly that the indiscriminate propagation of individuals selected simply on the basis of their performance alone led to no definite or permanent improvement in the race.

Now it is an interesting and significant fact that while this work was going on with grain crops in Sweden exactly the same kind of an experiment carried on by exactly the same kind of methods was going on in the State of Maine in the attempt to bring about increased egg production in poultry by breeding. In 1898 the Experiment Station began an experiment in breeding for egg production in which the method of procedure was as follows: A trap nest record was kept of the egg production of each individual bird. Only those birds were used as breeders in each year which made the highest egg records in the year before. This kind of breeding

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from the highest egg producers, making the selection simply on the basis of trap nest performance alone, was continued for nine years. When these results were analyzed by Dr. Raymond Pearl (1) the general result was found to be the same as that of the Svalof Station. The average annual egg production per bird showed no definite increase as a result of the close selection practiced. On the contrary an actual decrease in the average egg production per bird was observed. The plain and definite result of this experiment was that the practice of simply selecting the best layers as breeders did not improve the egg production of the flock.

The methods adopted in the two experiment Stations to meet these negative results amply justified themselves by the successes obtained. The mode of subsequent procedure consisted essentially in the adoption of the progeny performance test as the guide for all selective breeding. That is, the individual was selected for continued propagation only when the progeny of this individual proved superior. This method of propagation has shown the widest of application. In my own State its application to oat breeding by Dr. Surface (2) produced Maine 340, an oat which last year under test by the farmers produced 22 bushels per acre more than the other commercial varieties of oats with which comparisons were made. This demonstration was managed by the farmers, the only difference between the plots being Maine 340 seed oats used to seed one versus any other seed that the farmer wished to sow used to seed the other. The result is a truly significant demonstration of the value of a scientific principle independently derived by two widely separated scientists working in the field of genetics.

Probably no experiment station on this continent or this globe for that matter where similar methods are practiced but what could point to like accomplishments. Oats, barley, beans, cowpeas, wheat, in fact all of our important grains have shared in the benefits accruing from the improvement in seed due to selections based on the principle of progeny performance. Of the many striking examples Kanred wheat, developed by the Kansas Station (3), may be cited as one of the most prominent. The writer will have to ask pardon of the reader, however, if adheres pretty closely to the work with wh he has most intimate contact, namely work in the Biological Laboratory of Maine Station, for here the problems ha become more clearly crystalized in his mi

The results were just as pronounced in field of animal husbandry, for on the ad tion of a progeny performance basis which to select the breeders, the producti of eggs by the Maine Agricultural Expe ment Station flock immediately increased, increase being especially sharp for the str selected particularly for high winter p duction. From 22 eggs in 1906 and 20 e in 1907 the winter production of the fl when bred on a progeny basis rose stead until in 1914 the production had reached as the average winter production of the flo Where the breeding took as its object production of a strain of high produci birds the mean winter production of th birds rose almost at once to a high level about 50 eggs and continued at this le throughout the experiment (4).

Similar results were obtained by select on the progeny performance basis by Goodale (5) of the Massachusetts Exp ment Station. Here the annual egg prod tion of the flock increased from 124 e in 1913 to 228 in 1920. The increase be steadily upward through practically whole experiment.

Hybrid Vigor.

We may next turn to another type of sults furnished by the science of gene which has given us results of the grea importance when turned to the solution the farmer's problems. This applicatio newer to the field of applied genetics that previously presented in the above cussion. It is the application of the ph menon of hybrid vigor to the productio superior strains of seed, particularly of corn, to be utilized by the farmer in plantings for the purpose of increasing yields. Such increases are of course bro about by and solely through the agenc such improved seed.

The decrease of vigor and yield of from inbreeding is a phenomenon which been observed by many plant breeders a number of years. The fact of an inc

n vigor when two such widely separated in-red strains were crossed is also a result nown to many breeders. The scientific facts oncerning hybrid vigor in corn were work-d out independently by East (6) and Shull 7). The utilization of these facts in the ractical problem of breeding better seed orn traces to the work of East and his as-ociates Hayes and Jones. Before their im-ortant contribution to this field of practical reeding was made, many attempts to im-rove seed corn had been made by means of nass selections and ear to row methods. While these methods produced an increase f a few bushels per acre it is almost im-ossible to point to any really pronounced ractical results which have come from their pplication. The difficulty came from the ow recognized fact that in such methods nly the female parent was controlled. Since he male parent is just as important in in-eritance as the female parent it takes but ittle consideration to show that the methods f mass selection were not likely to be of ronounced value, a conclusion which has ctually worked out in practice.

East and Jones avoided this pitfall by racticing intensive inbreeding. In fact the orn was self-fertilized, in other words the ar was fertilized by the pollen coming from he anthers on the same plant. It has been ound that corn has many lines within any ommercial variety differing widely in yield nd other qualities. By this intensive in-reeding it was possible to bring these lines nto prominence. The inbred strains differed argely in yield and other desirable charac-ers. But as other investigators have found he inbreeding in itself reduced the general evel of yield for the strain which was thus nbred.

It was this fact which has appeared as the tumbling block to the utilization of this pro-ess by other investigators. East and Jones, owever, avoided the difficulty by inbreed-ng many lines at the start, selecting several f the best lines for yield and then by re-rossing them obtaining a crossbred corn ith very much increased hybrid vigor and a ombination of factors which was favorable o the highest of yields. In some of their ork these authors report crosses where the riginal inbred parent produced yields of about 50 bushels per acre each and the cross-bred first generation offspring produced yields of 112 bushels to the acre. The tre-mendous effect of hybrid vigor and of fav-orable combinations of factors is evident from these results. (8).

The general methods of utilizing hybrid vigor in applied genetics are well illustrated by the work of my colleague Doctor Sax on sweet corn, here at the Maine Agricultural Experiment Station. Sweet corn for canning purposes is one of the large industries of the State of Maine. It depends for its existence largely upon the quality of the product which is packed. Economically speaking, Maine is in a difficult position to compete with other States in the packing of sweet corn because of the fact that here in Maine the farmers must of necessity grow small acreages of corn and cannot therefore compete on a labor basis with the larger corn producing states where many times the acreage may be grown by one man. The problem from the applied genetic standpoint is the one of furnishing to the farmers here in this State a seed corn which will outyield in pounds of cut corn per acre the seed corn furnished to the farm-ers of other states and at the same time will maintain or increase the desirable quality of the Maine pack.

With these requirements in mind, work was started by inbreeding several lines of the standard Crosby corn, an excellent variety of white sweet corn used by the Maine packing industry. Such inbred ears when planted were usually found to show a reduction in size and vigor of the progeny. A large num-ber of inferior and abnormal types appeared, illustrated by white seedlings, weakly grow-ing plants, wrinkled leaves, etc. By con-tinually eliminating these weak types and selecting for a normal, vigorous progeny it was possible to concentrate in relatively few of these selfed lines the desirable character-istics of the strains from which they came. One could hardly believe that certain of the inbred strains were selected from a single variety only two or three years before for they differed in type, date of maturity, qual-ity, place on the stalk of bearing the ears, height and vigor, besides numerous other minor characters. When this inbreeding had progressed to a point where the better char-

acteristics of the strain were concentrated into a few individual lines these lines were crossed. The crossbreds when planted showed tremendous increases in vigor and yield of cut corn. Whereas the parent lines from which the crossbred lines were isolated would yield about 3,000 pounds of cut corn per acre some of these first generation hybrid lines yielded up to as much as 5,000 pounds per acre and all of these first generation lines yielded more than 4,000 pounds per acre of cut corn. At the same time the first generation offspring retained the desirable qualities of uniformity, excellence of type, similarity in their date of maturity and desirable flavor and tenderness. In fact, a corn which yielded 5,000 pounds to the acre was placed by the packers here in this State as being considerably above that of the commercial strains of the State and probably the leader among the crossed strains here described.

It seems as if applied genetics had but commenced to test the possibilities of this method. The method has the advantage that the offspring from such seed are not suitable for continued sowing. In other words, the grower returns to the original source of his seed and thus maintains the purity of it. In this way, with reliable seed companies, it is possible to retain in continued purity the advantages of the first generation hybrids. To me the application of these pure science results is a triumph of applied genetics. Here a practical method has been devised to utilize a highly productive, unstable form in the service of improved agriculture.

In the animal field the method does not offer so much promise although it is well recognized that hybrids such as the blue greys formed by crosses of the Aberdeen-Angus and Shorthorn or Galloway and Shorthorn result in some of the most desirable types of beef animals to be found.

The difficulty of the method lies in the fact that our large economic animals reproduce but few of their kind at one time. Thus the expense of maintaining the two parental herds necessary for making such crosses makes the method prohibitive in its cost.

For poultry the field looks more promising. Here the mother is capable of laying a fairly large number of eggs resulting in numerous offspring from a relatively small overhe in the stock which it is necessary to mainta The first generation crosses in poultry known to show hybrid vigor to a limited gree. The practice of crossing two carefu inbred strains relatively pure for high p duction and fertility characteristics appe to offer a promising field for the applicati of applied genetics. However, in contrast the plant field we find a very strong p judice among animal breeders against making of crossbreds. This fact combi with the greater expense of maintaining t flocks makes it doubtful if hybrid vigor w be utilized as a definite breeding progr between different breeds of our domestic a mals. It may, however, find a field which equally profitable although more limit when utilized for the improvement of st within a single breed. All our now accu lating evidence point to a remarkable div sity of economically important charact which have as yet been little utilized by animal breeder. This, no doubt, comes fr the fact that until very recently we h known but little concerning the mode of heritance of such characters. This lack information prevented the choice of suita matings to bring about the desired impro ments. With dairy cattle and with poul this difficulty is being rapidly overcome the increasing collection of information reaching a point where it is available or be available in the immediate future to swer these important questions.

Improvement of Varieties by Cross and Subsequent Selection of Pure Lines.

The method of crossing two varieties of which has desirable characteristics a with some which are undesirable and other desirable characteristics which complementary to the undesirable charac of the first cross along with some inf qualities is a time honored method of improvement. The aim in making su cross is of course the production of a va combining the desirable features of both ents without the undesirable features of e of the parents. Although this method plant improvement has been recognized many years, it was only with the appear of our knowledge on mendelism that i

came known how the mechanism worked by which such desirable combinations were brought about. While appealingly simple the method affords a vast number of combinations or recombinations by which the characters may be recombined in any one individual.

The basic principle is illustrated by literally hundreds of experiements, all typical of the following illustration. Black body color appeared in a single vinegar fly. When this fly was mated to the ordinary colored *Drosophila* (vinegar fly) the first generation offspring were typical wild, gray-bodied flies. The second generation from these crossbred flies gave three gray-bodied flies to one black-bodied fly. In other words, the hereditary substance causing black causes no visable effect in the first generation but produces one out of four flies black in the second generation. This result is brought about by a single inherited substance or factor present in the germ cells of the fly. The inheritance carriers or chromosomes are in duplicate, one from the sire and one from the dam. The original black fly carried the two sets alike for the black factor. When crossed to the gray fly the resulting offspring had one black and one gray factor and as the black factor was recessive the fly was to the eye, gray in appearance. The mating together of two of these flies allowed a recombination of these factors on the following principle. Black and gray mated to black and gray each had germ cells black or gray in equal proportions. All possible combinations of these germ cells resulted in one black and black, two black and gray, and one gray and gray; or in terms of what we see one black fly to three gray-bodied flies. This is the principle of the recombination of factors. Should we be dealing with two characters the possible recombinations would be sixteen instead of four. Three characters would make sixty-four recombinations. Obviously as the number of these single cases go up the number of possible recombinations becomes large, offering many chances for recombination which the breeder may desire.

Since the recognition of the method of recombination, progress has been much more rapid. We can point to many instances of the utilization of such methods in crop improvement. Perhaps one of the best of these is in the formation of Marquis wheat. While the early history of this wheat is somewhat obscure it appears certain that the female parent was Hard Red Calcutta and the male parent Red Fife. The original cross, made by William Saunders, was developed into the Marquis wheat by Charles E. Saunders by selection from the progeny of this cross. (9). This wheat in addition to being of the highest bread making quality is early in ripening, thus escaping rust; has yielding ability, stiff straw, excellent appearance, and wide adaptability. As is well known to all it occupies an almost unequalled prominence among the seed spring wheat. In a short twenty years this wheat has come to occupy the foremost place in the premier wheat growing regions of the world. Such is the progress of the products of applied genetics.

Round Tip tobacco is another specification made plant. The specifications were drawn up by the trade; the smoker of the leaf, the manufacturer of the leaf, and the grower of the leaf. This wrapper tobacco developed by East and Jones (10) for the Connecticut River Valley was developed from a cross of Sumatra and Broadleaf. It possesses a leaf nearly as large as the Broadleaf. Its leaves are ovate instead of lanceolate thus increasing the average number of wrappers cut from one leaf from nineteen on the old varieties to twenty-six on Round Tip. The leaves are upright and when cured possess all the desirable strength, elasticity, grain, and color characteristics. When made up the finished product for the lighter leaves closely resembles the Sumatra or for the darker leaves the imported Cuban wrapped cigars. Best of all from the farmer's viewpoint the crop is increased from 1500 to 2000 pounds per acre and the plants are uniformly disease and wind resistant.

It is unnecessary to take further space in illustrating this familiar method of the application of genetics to the breeding of superior producing strains (11). The very fact of its prominence, however, leads to another contribution of genetics to the practical science of breeding, namely, the setting of limitations to the probable success of this method. The work of my colleague, Doctor Sax, has made a pronounced contribution to this field by the combined study of the

cytology and genetics of wheat crosses (12). In the pure species of wheat, the Einkorn group had 7 haploid chromosomes. The Emmer group had 14 haploid chromosomes and the Vulgare group 21 haploid chromosomes. These groups are quite distinct in many characters. In the earliest history the Einkorn wheats were probably those grown in central Europe. Its lack of adaptability and many other undesirable characters caused it to be replaced early by the Emmer group. This wheat was in its turn replaced by the Vulgare varieties at about a time represented by the ascension of Greece to prominence in the World's history. Today we find that the Durum (Emmer group) and Vulgare varieties represent those chiefly grown. The Durum has a much more limited range and is grown because of its important drouth resistant characteristic. This characteristic has led many investigators to attempt breeding work designed to combine this character with the more desirable bread producing and yielding qualities of the Vulgare wheat. In other words, all unknown to these plant breeders they were attempting to cross a 14 chromosome wheat and a 21 chromosome wheat, and then to obtain from this cross a stable breeding wheat. The success attendant on breeding from these crosses has been so limited as to attract attention. The thousands of crosses made and studied have practically all tended to revert to either complete Durum or complete Vulgare characteristics with no recombination of the desirable qualities of each wheat. By this analysis of this problem from the genetic and cytological standpoint Doctor Sax was able to show that in the germ cell of these wheat crosses the chromosome behavior was abnormal. It is known that chromosomes are the bearers of the inherited characteristics of the individual, in other words, that the individual's appearance is due to the materials both in quantity and quality found in the chromosomes. This abnormal behavior of the chromosomes resulted in the lagging behind and apparent elimination of the incompatible chromosomes of one group or the other. Thus we have the crosses automatically returning to the characteristics of the Durum or Vulgare wheat. The cytological evidence then points to a reason for the difficulty experienced in combining the desirable characteristics of these two groups. It indicates one of the genetic difficulties in the path of the accomplishment of the desired recombination of the bread making qualities and yield of the Vulgare wheats with the drouth resistance of the Durums. It points to the probable necessity of a change in direction of breeding work designed to accomplish the ends of a more adaptable wheat for the arid regions, indicating rather that the prospects for the formation of such a wheat lie in the direction of extensive and intensive studies of wheats of the same chromosome number.

Some work carried on in this laboratory under the direction of Doctor Sax by his assistant, Mr. Smith, indicates that somewhat the same condition is found in the potato (13). Preliminary counts* have been made on the chromosome number of the forms of *Solanum*. It has been found that the haploid number of chromosomes for the species *Solanum chacoense* and *Solanum Jamesii* was 12. For the *Solanum tuberosum*, using the variety Green Mountain, the chromosome number was 24±1. On material which was not so well fixed as could have been desired the count for *Solanum Fendleri* was also found to be approximately 24. The form *Solanum demissum* the chromosome number was considerably above 24, probably 36. The first generation hybrid between *Solanum chacoense* and *Solanum Fendleri* and the form known as *Solanum maglia* show the lagging chromosomes characteristic of crosses between parents of different chromosome number where the chromosomes in the different groups are incompatible. On the other hand, reduction divisions of *Solanum tuberosum* do not show the lagging chromosomes.

The problem for potato is somewhat different from that of wheat in that the potato is reproduced from clones. The importance of complete fertility does not therefore occupy the same position that it does for the wheat. However, from a breeding standpoint, it is quite likely that when we are in search of desirable recombinations it may be equally important to adhere to the use of material where the cytological evidence does not allow chromosome incompatibility.

* The material for this work was kindly furnished by Dr. C. F. Clark of the Office of Horticultural and Pomological Investigations, U.S.D.A.

Clonal Varieties.

In clonally reproduced varieties like the apple and citrus fruit the chief improvements aside from plant introductions of unknown breeding have been the result of the continued vegetation propagation of the first generation hybrids between different varieties, as, for instance, in the Cortland apple. Besides such new varieties other improvements have been said to come from the selection of buds whose parental tree showed high yield. While the idea of bud mutation within a single clonal variety has been widely circulated as the probable explanation of variations of yield within that variety, the difficulties surrounding the proof of this statement are truely great. In a recent review of the evidence, Doctor Sax and myself were unable to find any but the most trivial evidence to support these claims of bud mutation influencing yield (14). On the other side, the evidence is more extensive, pointing to the fact that buds probably do not mutate within a clonal variety in such a way as to affect yield in more than a trifling per cent of cases.

The apple or orange trees have another important genetic cause of variation, namely, the fact that these trees are generally grafted or budded on to roots commonly known as stocks. These stocks are highly variable probably due to the fact that they come from cross-pollinated seed under most circumstances. There is every reason to suppose that such stocks would differ from one another in their inherited qualities for growth. The experiments of Webber (15) with citrus fruits tend to confirm the opinion that the slow growing stocks result in slow growing, and generally inferior yielding trees while the rapid growing stock result in vigorous trees. The same general conclusion is also found in the experiments at my own Station where the apple seedlings which were small resulted in grafted trees which were also small, while the seedling trees of larger size resulted when grafted in trees which were also of greater circumference (16). These investigations tend to point to a profitable path along which the field of applied genetics may progress. We may, I think, look for a development of the root stock industry for both citrus and pome fruits leading to strains of stock, bred in such a manner as to insure uniform vigor of the resulting grafted trees.

Self-sterility.

The tremendous importance of insuring fertility in all of our economic animals and plants has led the geneticists (17) to study the fertility in the different varieties of fruits and vegetables and the fertility relationship found in these varieties. It has been discovered that many of our most desirable fruits are self-sterile or nearly so, Thus in our work here in Maine we have found that practically all of the Maine varieties of apples are self-sterile (18). That is, the pollen of a tree coming from such a single variety will not fertilize the flowers either on its own tree or on the trees of the same variety to produce successful fruit growth. It is, in fact, only possible to obtain a proper fruit set on such a variety by crossing it with one which is compatible to it. The study of different varieties for their compatibility has produced some interesting results. It has been found that not only is a variety self-sterile with its own kind but that it is frequently sterile with other varities. Such being the case, in planting of large blocks of fruit trees it appears to be desirable to make provision for suitable varieties to act as pollenizers of such single variety blocks.

Genetic Contributions to Dairy Cattle Breeding.

The animal geneticist is in a somewhat different position from the plant geneticist in that the plant geneticist can carry the analysis of his problem to a point of actual seed distribution; he can bring to bear all of the thought in his science on the particular problem with which he is dealing up to the finished product, the farmer receiving only the seed which he may sow and reap without mental effort in its breeding. The animal geneticist, on the other hand, cannot do these things. He can bring to the farmer in the most elementary terms possible the results of his study of animal breeding problems. He can show how these results are to be applied to accomplish the ends sought but the farmer must do the applying. The farmer must put in the time and effort and intelligent thought necessary to grasp the principles and their application. With much of our animal husbandry work we can go no further.

In the field of dairy cattle breeding, however, we can do more.

In this field the breeders have organized themselves into Breed Organizations for the collection of accurate pedigree records both for parentage and for performance. These performance records appear in the Advanced Registries of the different breeds. These Advanced Registry records show the milk productions, butter-fat percentage, and butter-fat yield on the cows within the breed at whatever ages the test may have been made. These records are tabulated in a number of different ways but under all conditions the breeder must form his opinion of the worth of a given animal on the basis of milk records materially affected by age and where no summary or other means is given for the comparison of the different sires. In the furnishing of such a summary the animal geneticist may render a service to this great industry. With these thoughts in mind we have attempted the analysis of the 365-day Advanced Registry data of three of the most prominent breeds, the Jersey, Holstein-Friesian, and Guernsey (19). It is rather obvious that records made at different ages must be put on a standard age basis. This has been done for each of the breeds, the correction factors to correct for the age changes having been determined and applied to the individual records.

It appears to be almost axiomatic that the breeder's first aim is to know the transmitting ability of the animals which he breeds together to furnish offspring to build up his herd. This information is naturally most important for the herd bull because his offspring are much more numerous than those of the cows and because he constitutes half the inheritance given to these offspring. There are at least three ways of approaching this problem. The breeder desires among other things a bull which will obtain offspring of high milk and butter-fat producing ability. He desires further a bull which will constantly build up the herd making the next generation better than the previous one in its ability to produce milk and butter-fat. These desires indicate the method of approaching this problem. We can furnish to the breeder on an age-corrected basis the average production, butter-fat percentage, and butter-fat of the daughters of any Advanced Registry bull for the breed in which he is interested. This average will furnish the information to answer the first question. As the breeder further wishes to know if such bulls consistently produce high grade, medium grade, or poor daughters, we can also divide the range of production of these daughters into equal parts and indicate the percentage of daughters that have the different grades of production. In order words the geneticist can furnish information to show whether a bull's daughters are all in the highest eighth of production or fall outside this range into any of the other divisions of production from lowest to highest.

It appears equally true that for the owner a bull to be worth while must have daughters which are on the average larger in their production than the dams from which they came. Otherwise the bull has a harmful effect on the herd by reducing the average milk production of it. On the other hand, if a bull's daughters are on the average measurably better than the dams from which they came in productive qualities then that bull is exercising a beneficial effect on the breed. Concretely stated, we may say that a sire's transmitting power is equal to the average production of his daughters minus the average production of the dams to which he is bred. If the daughters' production is more than the dam's the sign will be plus (+). The bull is increasing the production of his daughters and consequently furthering the interests of the breed. If the daughter's production is less than the dam's the sign will be minus (−). The bull is consequently detrimental to the breed.

While the above principle is entirely within any herd it should be remembered in comparing the production of herds that the production of the dams will undoubtedly influence the difference between the dams and daughters' milk yields as a measure of the sire's transmitting ability. Thus it is more difficult for a sire to raise the production of his daughters if the dams to which he is bred are of exceedingly high production. It is much easier for him to raise the production of these daughters if the dams' production is low. This fact does not influence any such comparison as that

ould be made by the owner of the herd. It nly influences the comparison of the productive capacity of one bull in one herd with ie productive capacity of another bull in nother herd.

For this problem we can arrive at the sire's ransmitting power on a slightly different asis. From inheritance studies we can deterine what the average production of daughers will be when they come from dams of iven grades of production. Thus for the Iolstein-Friesian breed, dams which milk 0,000 pounds have daughters with an averge milk production of 15,081 pounds, * hile dams which have a production of 6,000 pounds have daughters with an averge production of 23,279 pounds. From hese average productions of daughters for ach grade of dam we may then determine he transmitting powers of a sire by subracting the production of a sire's daughters rom the average production expected of these laughters determined from the production of he dams from which they came. These nethods of approaching the problem give us ather completely, precise measures of the enotype of the individual sire as differeniated from any knowledge of the somatic erformance or characteristics of that sire. hey furnish the real measures of the animal s a breeder. Since this is the sole purpose or which bulls are kept in the dairy breeds hey furnish a measure of the bull's true vorth for unless he can produce progeny of nerit it matters little whether his pedigree races through seven or eight generations of he fanciest ancestry.

Before making the comparisons to determine the progeny performance of each sire t is necessary to obtain an accurate method f correction of milk production for age. After considerable study it was possible to how that for the Guernsey breed a curve f the following type would fit the actual nilk yields for the cows in the breed at the lifferent ages of the record. This equation s:

Mean milk yield=

$6{,}372.6+827.9a-51.8a^2+1394.6\ (\log)\ a-1.25$

where the age a is in years and the origin is 0 years. That this curve fits the data accurately is shown in figure 1.

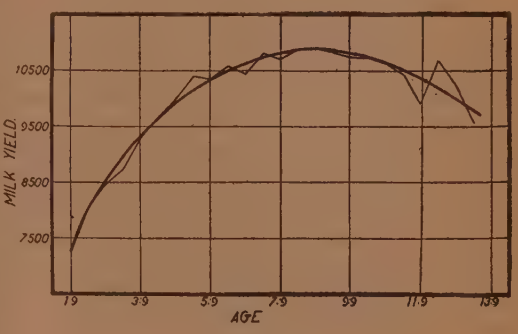

Figure 1.

Figure 1. Observational and fitted curve showing the relation of the 365-day milk yield to age in Guernsey cattle. The observational curve is the rough curve and the theoretical curve the smooth curve.

In a similar manner it is necessary to determine the relation between age and butter-fat percentage for these cattle. This equation was found to be of the linear type.

Butter-fat percentage=5.147–.025 age.

There were more than 1400 Guernsey sires on which data were available to determine the performance of their progeny. It is obviously impossible to give anything like the total for these results. Such being the case only the first 43 sires are presented, as a sample of the results obtained in such work.

The first column of table 1 gives the place occupied by the bull in a series of bulls where the bulls are arranged according to the average production of their daughters. The second column gives the name of bull. The third column his herd book number, the fourth column the number of daughters with 365-day records found for this bull in the Advanced Registry. The average age corrected milk production of these daughters is given in the fifth column. The sixth column gives a rapid means of mentally visualizing the production of the daughters of a given bull. The range of production is divided into eight parts such that each part

* See Milk Secretion, Williams and Wilkins o., Baltimore, U.S.A., for further data on this oint.

TABLE I.

Performance of the Progeny of Guernsey Sires for the Average Milk Production of their Daughters.

No.	NAME	H. B. No.	No. of Daughtrs.	Average Milk Yield	Octiles
1	Beacon Light B.	9417	2	17761	100 I
2	Missy's May Rose Kng of the Glen	19660 R.G.A.	2	17372	100 I
3	Iagoo II.	S.2167 P.S.	3	16717	100 I
4	Langwater Warrior	26509	5	16395	80 I+20 J
5	King Masher of Chilmark	27643	2	15477	100 I
6	King of Birchwood	27366	2	15465	100 I
7	Newgrove King of Briarbank	27362	2	15345	50 I+50 L
8	Mambrino	10085	3	13538	100 I
9	Glenwood Bishop	9186	4	15320	100 I
10	Dumont's Hero	18862	2	15189	50 I+50 L
11	Nadieno	20432	3	15099	67 I+33 J
12	Langwater Monarch	20899	4	14942	100 I
13	Mora of Genesse	13457	2	14831	50 I+50 J
14	Langwater Hayes Rosie's King of the May	16723	16	14792	63 I + 19 J + 6 K + 13 M
15	Marshall of Waddington	14320	2	14783	50 I + 50 K
16	Langwater Holliston	28055	5	14746	60 I + 40 J
17	Imp. Hayes Prince of Spotswood	8129	2	14689	100 I
18	Gold Lassie's Julian	27704	9	14665	67 I + 11 J + 22 K
19	Masher's Sequel 3d	13031	3	14600	67 I + 33 J
20	Harbor Hill's Linden Masher	27831	2	14546	100 I
21	Imp. Sequel's Budget II	21327	3	14499	67 I + 33 J
22	Dairymaid's Nonpareil of Iowa	26763	2	14486	50 I + 50 L
23	Dairymaid's Glenwood of Pinehurst 8th	30900	2	14469	100 I
24	King Masher	11084	11	14460	641+18J+9K +9L
25	Mogul of Haddon	28228	2	14436	501+50J
26	Jardiniere's Masher	20957	11	14391	551+36J+9M
27	Rutila's May King of Linda Vista	17945	3	14378	331+67J
28	Tristan's Douglas	28959	2	14375	100 I
29	Ultra May King	27600	8	14370	501+38J+13K
30	Lennard 2d	2162E. G.H.B.	2	14344	501+50J
31	King of Chilmark	20798	10	14317	701+10J+20M
32	Imp. Holden IV	12179	7	14275	571+14J+14K +14M
33	Imp. King of the May	9001	29	14253	581+17J+7K +7L+7M+3
34	May King of Maplehurst	16050	2	14252	501+50J
35	Ne Plus Ultra 4th	29328	8	14243	631+25K+13
36	Dairymaid's Prince	26353	2	14219	100 I
37	Baron of Sarnia	20687	2	14165	501+50N
38	Imp. Florham Governor	10213	2	14152	501+50P
39	Eminent of Sarnia	32963	4	14091	751+25J
40	Sterling Lad	17655	3	14054	671+33J
41	Marcia's Glenwood of Pinehurst	11560	2	14028	100 I
42	Bob Rilma's Monogram	29095	3	13960	671+33J
43	John Q. of Edgewater	20967	6	13956	501+33J+171

includes within its limits one-eighth of the total number of milk producing cows. The highest eighth is called I, the next highest J, K is the third highest, and so on down to the lowest milk producing group, or P.

This table furnishes to the Guernsey br er information such as he has never had fore on which to base judgment of the herited qualities transmitted by the di ent bulls in the breed. It is the real

geny performance test which as we have seen in the studies of oats, corn, the small grains, or poultry, is the only method by which we can hope to attain success in the breeding of superior lines of plants and livestock.

Some of the results which flow from this table may be illustrated by taking one of the more obvious bulls. We find that of the bulls that have over 10 daughters the sire Langwater Hayes Rosie's King of the May had daughters of the highest average milk production. This sire on the basis of these daughters' performance was 14th in the list of 1400 sires. His herd book number was 16723 and the average milk production of his daughters was 14792 pounds. Sixty-three per cent of these daughters were in the highest class of milk producers or the I class. Nineteen were in the next highest class of milk producers. Six per cent were in the third class of milk producers and thirteen per cent were in the fifth class of milk producers. The productive capacity of this sire's daughters was slightly greater than that of those sired by his own father Imported King of the May, the 33rd sire in this list. King of the May had 29 daughters with 14,253 pounds of milk as their average production. Fifty-eight per cent were in the highest class of producers as against sixty-three per cent for Langwater Hayes Rosie's King of the May. The rest of King of the May's daughters were distributed in lessening percentages through the higher classes of milk producers.

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The Modern Trend of Forage Crop Improvement.*

G. P. McROSTIE

Dominion Agrostologist, Central Experimental Farm, Ottawa.

I presume that the term modern is used, or perhaps abused as much or more than most other words in characterizing the tendencies of any period, either agricultural or otherwise. Whatever else people may differ about most individuals feel rather pleased with themselves if they can be termed modern. Agricultural workers are no exception to this rule not even when it comes to breeders of forage crops. For the purpose of this paper, however, modern will be used simply as pertaining to the present period and without any insinuations of inefficiency or ancientness of practices or theories of the days gone by.

I wish to consider the topic from three different angles:—

1. Modern trend with regard to crop distribution and classification.
2. Modern trend with regard to experimental methods.
3. Modern trend with regard to crop improvement.

Let us consider first the question of crop distribution and classification.

The breeder of Forage Crops has not long been confronted with the same distribution problems as has the breeder of the cereal crops. This has been due chiefly to the fact that, almost without exception the cereal crops are self fertilized, and therefore lend themselves readily to separation into pure lines, while forage crops are for the most part open fertilized, and consequently tend to remain mixtures. This is why our farmers when they go into a seed store to purchase their spring supply of seed ask for Banner Oats, Alaska Oats, O.A.C. No. 72 Oats, etc., but only for "Timothy or Red Clover" when desiring these latter commodities.

Some of our forage crops, however, have been purified to a sufficient degree that the grower also asks for them under a variety name. This is particularly true of our hoed crops, especially corn and field roots. The varieties thus obtained are not always satisfactory with regard to their purity, nor does a grower always receive the same product in succeeding years, even though he buys under the same variety name. Even though the buying of seed is yet more or less of a gamble, the fact that enough selection has been done to warrant the separation of our crops into groups, the individuals of which resemble each other at least to some extent, is encouraging in that it is an advance over the buying of undifferentiated commercial mixtures.

As our Forage Crops increase in purity we find ourselves in the same quandary as the cerealists in trying to decide the relative advantages of developing varieties for small agricultural areas and thus increasing the production of those areas or, ignoring small areas, limiting our varieties to as few as possible, recognizing only their adaptability to the larger agricultural zones. Whatever the merits of either view may be the defining of definite agricultural zones would be a distinct advantage. The present tendency in that direction is perhaps exemplified best by the production and distribution of field corn.

In order to make use of definitely defined agricultural zones it is necessary that we have an accompanying crop classification, that will give us information regarding the special adaptation of the various varieties and strains of our forage crops that are offered for sale. There has been a very serious lack in this connection. Let me illustrate my point by reference to a classification of field mangels that we have partially completed at the Central Experimental Farm at Ottawa during the past few years. In some cases the advertised variety name gave no indication whatever of the possible type to which the mangel might belong, and in more cases the type as advertised failed to materialize in the resulting crop.

* Paper presented at the 4th Annual Convention of the C.S.T.A.

I will outline very briefly our basis of classification and then give you a few examples of our findings with regard to field roots purchased from certain seedsmen whose names I will not mention at this time.

In examining the various seed catalogues it is evident that the seedsmen are already recognizing distinct types in their advertising. You see illustrated in the mangel section of the catalogues long types as long red, long yellow etc.; half long types as the half long sugar mangels; intermediate types as the yellow intermediate; red intermediate etc.; tankard types as the golden tankard; ovoid types as the yellow ovoid; globe types as golden globe, yellow globe, etc. Our idea was to define this fairly apparent classification already existing and to ascertain, if possible, if it was based on economic differences in the various types of roots as advertised.

To accomplish our object in this connection we made in the neighborhood of ten thousand measurements of mangel varieties secured from our best Canadian, American, British, Scandinavian and other European seedsmen. Four separate measurements were made of each root studied. These were length, width at widest part of the root, depth in the ground, and finally the distance from the tip of the root to the widest part. As it is obviously the relationship of the various measurements to each other rather than the absolute figure that is significant the length of each root was divided by each of the other three measurements to obtain ratios whereby roots of the various types could be compared on common ground.

The following table gives the average ratio of all the measurements of the varieties representing the different types listed by the seedsmen:

Variety	Length Width Ratio	Length Depth Ratio	Length Distance To Widest Point Ratio
Long	3.310	1.981	1.299
Half Long	2.915	2.044	1.329
Intermediate	2.065	2.261	1.511
Tankard	1.594	2.088	——
Ovoid*	——	——	——
Globe	1.074	2.405	1.597

*Insufficient measurements for classification.

An examination of this table will reveal the fact that there is a well defined differenc between the length-width and length-dept ratios of the five types reported. These di ferences in the two ratios mentioned are d finitely co-related with adaptations to pa ticular soil types and conditions and th classification should therefore be considere to be of economic significance.

Now let us see in how far some of th varieties as sold exceed or fall short of th mark when considered in the light of o classification: One seedsman advertised f sale a mangel under the name of gold tankard. In their description of this type root the following claims were made: "O stock has been selected and re-selected f years and has been so improved as to ha scarcely anything in common with the dinary types of this variety." Our analy of this particular variety of mangel showi the following: 55.19% intermediate, 19.85 globes, 7.35% ovoids, 2.20% long.

Another seedsman makes the statement c cerning a monarch sugar mangel sold them: "Remarkable even in shape." T statement is undoubtedly true in the li of the fact that generous proportions globes, ovoids, tankards and half long r types were present, in addition to what t variety was supposed to be. A third see man advertised as a "Uniform tankard ty roots that contained 18.64% intermedi 6.78% ovoids, 1.69% globes and 1.69% l mangels. These three cases are only sam of a considerable number of such illus tions.

I do not want it thought because these illustrations that all seed sold by seedsmen is misrepresented. In fact seedsmen sell only poor varieties and s of the seed offered to Canadian grower exceptionally good.

The illustrations quoted are sufficient, h ever, to emphasize the necessity of a work classification of field roots if the grower this country are to receive the protec which should be theirs under the new S Control Act.

The trend of forage crop improvemen the connection that we have just been sidering seems to be towards the estab ment of fairly well defined agricultural z

and the classification of our various forage crops on the basis of their suitability for the zones as established.

In the second section of my paper I wish to mention a few of the present day tendencies with regard to experimental methods with forage crops as I have observed such methods at various colleges and stations that I have come in contact with during the past few years.

Most of the points I wish to touch on will be in connection with the comparative tests of varieties or strains, or of differing agricultural practices.

The comparative test is primarily for the purpose of determining the relative value of the varieties, strains or practices under test. If then the method of conducting such tests is inaccurate in any way the greatest asset of the comparative test is lost.

I will illustrate my point by reference to one phase of forage crop tests. If you will go back over the reported yields of corn, sunflowers and field roots of all kinds as such yields were reported a few years ago you will observe that almost universally they were reported in terms of the harvested or green weights, and the conclusions as to their relative value based on the yields as then reported.

In this connection I wish to bring before you a few figures taken from our comparative yield tables for some forage crops grown at the Central Experimental Farm during the summer of 1923:

YIELDS OF MANGEL VARIETIES

VARIETY	SOURCE	DRY MATTER YIELD PER ACRE Tons	Lbs.	RELATIVE PLACING	YIELD PER ACRE AS HARVESTED Tons	Lbs.	RELATIVE PLACING
low Intermediate ...	C. E. F., Ottawa	5	1578	1	49	453	3
nt White ½ Sugar .	Wm. Ewing, Montreal ..	5	1388	2	39	1579	7
endorfer Yellow	Hjalmar Hartmann, Copenhagen	5	1348	3	53	1157	1
ish Sludstrup	Wm. Ewing, Montreal ..	5	1217	4	40	409	6
mmoth Long Red	Halifax Seed Co.	5	1204	5	33	1695	10
nt Sugar Mangel ite	Graham Bros., Ottawa..	5	888	6	37	932	8
ish Sludstrup	Depuy and Ferguson, Montreal	5	888	7	40	1866	5
v Ideal	Steele-Briggs, Toronto ..	5	833	8	49	1114	2
Sugar White	Depuy and Ferguson, Montreal	5	819	9	36	1699	9
rojc Barres	Hjalmar Hartmann, Copenhagen	5	732	10	49	277	4

The data reported in the foregoing table represent the yields of the ten varieties of field mangels which gave the highest yield of dry matter per acre. They are arranged in the order of decreasing yield of dry matter. In the fifth column the yields of harvested material are given and in the sixth column the relative placing of these same varieties based on the yield of harvested material secured from the different varieties concerned.

If we are correct in our assumption that the dry matter contained in our various forage crops is the all important consideration the reporting of mangel yields in terms of harvested material as indicated in the included table is obviously misleading. An examination of the data in question indicated that

the relative position of the reported varieties is very radically changed by reporting in terms of absolute dry material rather than in terms of green weights.

Yield data secured with a few strains of Western Rye grass will serve further to illustrate the points under consideration in so far as grasses are concerned:

YIELDS OF WESTERN RYE GRASS STRAINS

BORDER EXCLUDED						BORDER INCLUDED		BORDER EFFECT
GREEN WT. PER 1000 PLANTS GMS	RELATIVE PLACING	AIR DRY WT. 1000 PLANTS GMS	RELATIVE PLACING	ABSOLUTE DRY WT. PER 1000 PLANTS GMS	RELATIVE PLACING	ABSOLUTE DRY WT. PER 1000 PLANTS GMS	RELATIVE PLACING	BORDER EFFECT %
933.333	1	386.493	1	364.559	1	369.674	1	1.402
819.444	2	346.706	2	324.499	2	345.761	2	6.552
750.000	3	337.059	3	312.525	4	339.610	3	8.666
701.754	4	326.596	5	307.227	5	313.006	7	1.881
700.000	5	312.760	6	291.550	6	291.145	4	−0.138
694.805	6	287.788	10	268.750	10	295.787	10	10.060
690.000	7	298.770	7	280.347	12	287.118	12	2.415
689.024	8	269.270	14	251.562	14	262.661	14	4.412
638.888	9	331.391	3	312.544	5	330.792	5	5.838
638.888	10	275.935	11	264.435	9	301.801	9	14.130
637.254	11	298.107	9	275.102	4	332.458	4	20.848
582.191	12	296.743	8	280.266	6	318.240	6	13.549
578.125	13	275.418	13	255.300	13	274.873	13	7.666
572.164	14	270.404	15	246.945	15	257.022	15	4.080
524.193	15	277.245	12	261.152	8	306.210	8	17.253

An examination of the data presented will bring out the fact here also that the relative positions of the different strains under test varies with the condition of the grass when the weights from which the yields were computed, were secured.

Where differences between yields are very large they may offset any change of relative placing due to varying moisture content of the harvested material. When such differences are not large, however, a very marked alteration of relative placing occurs with each stage of drying.

The Western Rye data also bring out the fact that the inclusion of the border foot in compution of the plot yields again disturbs the relative yields of the strains reported on.

In mixtures, especially where the coarser legumes are included in varying amounts, the influences that we have been considering which disturb the relative placing of the varieties or strains under test are even more exaggerated.

A great many more considerations might be mentioned in connection with this section of my paper such as the influence of of seeding, number of replications, etc., on the result obtained.

What I have been trying to demonstrate is the fact in as far as methods are concerned the modern tendency is quite evidently in the direction of greater accuracy in carrying out the various operations connected with our experimental practices in order that the conclusions which we draw from the results of such experiments may be as accurate as possible. Co-operation of effort along this line is speeding our advancement.

The final phase which I wish to consider at this time is the present day tendency with respect to crop improvement.

Because of the fact that forage crops, being for the most part open fertilized, do not lend themselves as readily to improvement as do the self fertilized cereals, much less advancement as been made in their improvement

an in the case of the cereal crops. Until te years practically all improvement has een obtained by means of mass collection of perior individuals or groups of individuals. the case of our field roots and our corn is system has resulted in the separation of ese, however, there still exist undesirable dividuals.

Recent developments in the study of gene- cs has led us to believe that there may be a ster and perhaps a surer way of getting rid undesirable individuals than by the rather ow-working mass selection or the so called fined mass selection (as illustrated by the r-to-row breeding in the case of corn).

The whole purpose of all plant improve- ent is to separate the undesirable from the esirable plants, discard the former and con- nue the latter. To discard an undesirable lant or to continue a desirable one it is ecessary to handle the plants in such a way at their individual characteristics may be cognized. This means of course purifying e plant with regard to the various charac- rs or factors that go to make it up. This an most quickly be done by self fertilizing e plant. Four or five generations of self rtilization will transform a miscellaneous ixture into its component true breeding rains.

The inbreeding resulting from continued lf-fertilization in many cases is accompanied y a decrease in yield of the purified strains. n such cases a recombination of the more esirable strains is necessary to regain hybrid igor. This new combination of plants, how- ver, resulting from the recombination of e more desirable purified strains, is in early all cases a much more profitable mix- re to grow than the original mixture.

Some classes of forage crops have shown marked degree of self sterility. Most work- rs have found this to be true with regard red clover and sunflowers. However, at e Kentucky Experimental Station they have ound that red clover plants differ very mark- dly in the degree of self sterility that they xhibit. Similarly at Ottawa we have found at while some strains of sunflowers appear be self sterile quite a number are not so. n the summer of 1923 we self fertilized ver ten thousand individual sunflower plants nd from most of these secured a fairly large umber of viable seeds. In fact most of the sunflower plants self fertilized during 1923 were the progeny of parents that had been self fertilized for four generations.

While sunflowers behave much the same as corn in that the inbred strains are consider- ably smaller than the original mixture from which they came,most of our commonly cul- tivated grasses do not show this reduction in size and yield. Many of our best timothy strains which have been inbred for five gen- erations at the Central Experimental Farm consistently give a higher yield than the best commercial mixtures with which they have been tested. The highest yielding ones also give a higher yield than the recombination resulting from the mixing of the various in- bred strains.

In the case of alfalfa our experimental work has not been continued sufficiently long for us to feel safe in expressing an opinion as to whether or not the recombination of superior strains will be superior in yielding capacity to the best inbred strains themselves.

What I have mentioned in connection with breeding work will serve to illustrate that the present day trend of improving forage crops is in the direction of the elimination of the undesirable types where possible by inbreeding.

A further trend is towards the utilization of the hybrid vigor exhibited by many first generation plants resulting from crosses of dissimilar types, either pure strains or other- wise, to secure increased yields for a single generation.

The corn crop is one in which such hybrids promise to be of considerable economic value. In our 1923 variety tests at our corn breed- ing station at Harrow, Ontario, a double- crossed hybrid corn originated by Dr. Jones of the Connecticut Experimental Station at New Haven, Conn., outyielding all other var- ieties with which it was tested both for the production of fodder and grain.

Finally there is a modern trend among our plant breeders of all kinds to co-operate more fully in the carrying out of the various phases of our experimental work. Such co- operation means better and more uniform results and consequently a greater confidence on the part of agricultural producers in the ability of the plant breeders of this and other countries to meet the obligations and oppor- tunities that are theirs.

Studies in Nutrition as Guides in Horticultural Practice.*

E. J. KRAUS

University of Wisconsin, Madison, Wis.

If one grants that there is a correlation between the amount of growth made by a plant and its degree of fruitfulness, a more intimate explanation of this fact still remains to be made. At present no ultimate accounting of the causes of growth can be given, nor can the exact substances or materials most closely associated with, or constituting the developmental behavior of plants be defined. The general nutrient, moisture, temperature, and light conditions necessary for growth, however, have been fairly well defined. To be sure, no small amount of the evidence is conflicting, so that there remains much to be gained from more critical experimentation, but the foundations for future studies have been laid. Many more careful investigations attempting to get at the relationship of materials within the plants themselves, are needed.

It now seems likely that it will be possible to correlate fairly closely the tendencies of plants toward vegetativeness, fruitfulness, or the varying combinations and degrees of these manifestations, with the composition of such plants. This really must be possible, and if the findings to date have not been entirely convincing it is because we have not yet learned just what substances are critical, or because our methods of analysis are not wholly satisfactory, rather than that the idea is completely an error of judgement.

If, in the final analysis, a plant may be regarded as an aggregation of certain materials, and if its various states may be looked upon as variations in the proportions of those materials, the study of the problem of plant development becomes somewhat more clear. Naturally it is not assumed that there is anything novel in this idea, but to speak of plants as having a certain height, volume, dry weight, or other characteristics has been such a convenient escape from accurate definition, that it seems well to restate i Yield records from plot experiments are i valuable, but they often fail to give even clue to the character of that yield; one mu frequently draw his inferences from the co ditions of the experiment. Nor are chemic determinations lacking; but a bringing t gether of these from many sources is badl needed. Analyses of organic constituents plants are less numerous, and many of the are neither sufficiently detailed nor exact be very helpful. What is most needed at t present time is the refinement and standar ization of methods of analysis. It is no difficult for one investigator completely follow the work of another because of vari tions in making determinations of the sa substance. It is also impossible to apply t same method of analysis with equal co fidence to all types of plants, or even to a types of conditions of the same plant. Pr gres is being made, however, and the ti is certainly not distant when conditions this respect will be greatly improved. C tainly one thing is wholly unprofitable present, and that is the needless criticism one's fellow workers whose results may se to diverge from one's own. Obvious err should be indicated for improvement, course, but the very best that can be do now is the securing of approximations. these be as near exact as possible, and o need have no fear about future progress.

One of the reasons why it has seemed sirable to try to get at the composition of plant itself as an indicator of its conditi or state of development, rather than to r wholly on an examination of the elements its external environment, is because of fact that under apparently similar envir ments plants have behaved so differently. a matter of fact, of course, the environme studied have not always been exact du cates. Under other circumstances, althou the environments may have been the sa

* Paper given at the Fourth Annual Convention, C.S.T.A. June, 1924.

the plants subjected to them were not exact replicates. Naturally the results secured showed wide variations. This last condition has prevailed frequently when perennial plants were used in fertilizer, pruning, spraying, and other types of experiment. Here a knowledge of the composition of the plant worked with is of the very highest value. The changes induced in its composition relative to changing environments and the correlation of these with its appearance and behavior give clues of real help in the determination of the value of agricultural practice.

The proposals made some years ago by Kraus and Kraybill concerning the composition of plants in relation to their appearance and behavior seem to be proving helpful to a somewhat clearer understanding of some orchard problems. These proposals were the result of work on plants growing under the usual conditions of spring and summer light and temperature, with a plant, (the tomato) which, under changes in the length of exposure to full sunlight, responds almost in direct proportion to the amount of light received. Additional investigation now makes it certain that these proposals when amplified and refined as to specific details, can be made to apply to a wide range of plants and conditions.

It was suggested that on the basis of the relative availability of a carbohydrate reserve, or opportunity for carbohydrate synthesis, to the nitrogen supply about or especially within the plant—four classes of condition and behavior could be distinguished, provided of course that all other essential elements, including water, were not limiting factors. These classes are as follows. First, if the carbohydrates are limiting, the plant is feebly vegetative and not fruitful. Second, if the carbohydrates are in an abundant supply and there is an abundance of available nitrogen, the plant is vigorously vegetative, but not fruitful. Third, if the carbohydrate supply is still more abundant, the plant is not only vegetative but is fruitful as well. Fourth, if nitrogen is limiting, the plant is feebly vegetative, usually weakly fruitful if at all so, and may even fail to produce floral parts. Of course each class merges into the one next to it, the gradation usually being gradual. This is well illustrated between classes one and two, which differ in degrees of vegetativeness. As two merges into three, one may expect to find various monstrosities in flower and fruit structures. As three merges into four the relative decrease in vegetativeness often associated with the differentiation of great numbers of floral structures is noticeable. The observation of that condition was for a long time one of the main causes of confusion in recommendations for practice based on the idea that any factor which will suppress vegetativeness necessarily increases fruitfulness. A moment's reflection indicates the half truth of that suggestion for class one is also weakly vegetative.

The foregoing suggestions naturally suggested the abandonment of some practices and the institution of others, based on the possibility of influencing the material make-up of plants. But they left much still to be desired in the way of a clear, more nearly exact definition of the materials concerned with growth. Unfortunately these are not yet available, but the problem is far from a hopeless one. The work of Garner and Allard on the influence of length of day on plant development may have seemed to complicate the issue for a time. As a matter of fact, however, these studies coupled with those of Harvey, Nightingale, and others, have actually enormously widened the field of attack and put new tools into the hands of the workers, for getting at problems of nutrition. The influence of light, one of the most troublesome complicating factors in experimental work, the cause of no end of apparently conflicting evidence, is beginning to be determined, and in the process the knowledge of plant nutrition and development is gaining enormously. When Nightingale found, for example, that plants which were subjected to a seven hour light exposure and were blooming, contained an abundance of carbohydrates and nitrates, the suggestion that nitrates in themselves were largely responsible for the vegetative condition seemed tenable no longer. They must really represent only an unassimilated reserve. When he found that vegetative plants of the same variety of plant growing under a longer light exposure were not only rich in nitrates but also contained large quantities of water sol-

uble organic nitrogen complexes though low in carbohydrates, a step in advance had been taken since it was indicated that the water soluble organic nitrogen compounds may be most significant in the vegetative condition. The knowledge of the compounds concerned in growth was to that extent increased, and a method by which studies could be made to push that knowledge still further forward, had been disclosed. The additional finding that the several classes of plants responding as differently as they do photoperiodically, differed consistently in their chemical composition, gave confidence of future success in working out specific details. Up to the present time, the general proposals correlating the vegetative and fruiting condition in plants with the proportions of carbohydrates and nitrogenous compounds of which they are made up have been substantiated, and the details have been extended. The specific nature of the nitrogenous compounds can be told more closely. Some approximations toward a knowledge of this formation will be gained and at least some additional rough estimates of the functions of light in plant development will be possible. On the results of such studies we may confidently expect to found stable practices dealing with the use of artificial and natural illumination in greenhouses, at least a partial explanation of the results of field trials conducted north and south, and certainly they will be a material aid in clarifying our understanding of the whole fertilizer problem. The experimentalist will find that a part of the assumed exceptions and conflicting results may be arranged in a more orderly fashion, and something approaching harmony established.

The results produced by light, of course, are but a few of the many resulting from the interplay of external factors, which can at least partially be cleared up by a careful examination and analysis of the structure and composition of the plants themselves. How far it is possible to substitute some of the effects produced by light by other factors is important to known—whether such effects are real or apparent. Likewise in how far the effects of light are offset by other factors still requires much investigation. Evidence relating to the influence of temperature is accumulating. The work of L. R. Jones and his associates, Gerricke, Eaton, and others, is opening up the problem of growth and development from the angle of the influence of temperature. Here too enormous contributions are being made, and again a factor, which where not completely controlled has resulted in a troublesome complication of evidence, is being studied and given its true values. Chemical investigations by many workers are in progress. Such studies as these, coupled with other investigations, exact quantitative measurements, and an examination of the structural details of the plants under investigation will give information sufficiently detailed and exact that the present necessity for apology for suggestions which have not provven wholly sound will be eliminated.

The investigations of Chandler on the influence of water in development and behavior of fruit trees and the large numbers of studies made by many investigators in various places are of greatest significance in regions where water is likely to prove a limiting factor during the growing season. The effects of nitrogenous substances, carbohydrates, temperature, all must be correlated with moisture supply. The irrigation farmer of the west, the farmer on the drained lands of the various sections know something of the value of water. But unfortunately also some of these farmers have had to learn for themselves that many deserts fail to bloom as the rose despite the water applied to them, and that many marsh lands fail to produce the abundance expected until other conditions are corrected, or nutrient elements are supplied. Isn't it soon going to be possible to know sufficiently well in advance the conditions necessary for plant development that such unfortunate situations need no longer arise? Intimate work and study of these problems will certainly hasten that time, but to do this one must know plants in detail and recognize them for the delicately balanced, constantly changing individuals which they are, rather than as tons of dry matter.

In conclusion it seems worth while to mention an instance recently brought to my attention by Professor L. F. Graber, of Wisconsin, which illustrates fairly well the possibilities of making practical suggestions from even the approximate studies on plant nutrition which are available. It has been a practice

for some years to cut alfalfa at a so-called tenth-bloom stage, or for an even finer quality of hay, at an early-bud stage. As compared with later cuttings it was found that though the early cuttings were made more frequently, much more hay could be secured from the less frequent, later cuttings than from the frequent early ones. It was observed also that the plants, decreased in vigor, when subjected to the early and frequent cuttings. They were often killed out completely following several successive cuttings in a very early stage of growth, and were far less winter hardy. Fertilizer treatments to correct the difficulties had been tried without advantage. It had been observed on the contrary that the plants which had reached the full bloom stage before cutting, regenerated much more rapidly, abundantly, and vigorously. Some of these findings suggest to the horticulturist the results of summer pruning of trees and all that that practice has meant in the way of delusions when carried to the extreme. It also suggests, on second thought, that from the standpoint of nutrition very early cutting must bring about a reduction of stored foods, and likewise a marked reduction of the possibilities for subsequent food manufacture. The plants should therefore fall in class one. What should be the remedy? Obviously to allow the tops and leaves to remain sufficiently long to make some return to the roots. To test how long a period is required for such return to be made, cutting experiments showed that plants cut in the tenth-bloom stage regenerated moderately well, but were weakened; those cut in the full bloom stage regenerated abundantly and vigorously; those cut in the seed-pod stage regenerated even more abundantly, but the hay secured under such circumstances was too woody to be of much value. Cutting in the full bloom stage seems to be a practical compromise, though of course when alfalfa is used in a short rotation, an even earlier stage of cutting is acceptable, the yield being less in quantity but a somewhat finer quality of hay. Waters had already found the same general result with timothy.

One point worthy of note here is the fact that seed production under the conditions of the experiments noted was not a devitalizing process as it is sometimes supposed to be. Nor did Waters find it to be such in the case of timothy. Naturally a great deal of careful investigation is being done on this problem. Growth measurements, determinations of the rate of increase in root diameter, records of total yields, chemical analyses of roots and tops at various seasons and under varying conditions, and histological examinations are being made. But as previously stated, practical suggestions can be made even from approximations when the various factors of the environment so far as known are taken into consideration and attempts made to correlate them.

It has not been the purpose of this discussion to take up specific practices and attempt to analyze them. Such an analysis can be made and fairly valuable suggestions derived, but no final word on any specific practice can be given because as yet there are enormous gaps in our knowledge. The general reactions which pants undergo in relation to the various factors of the environment are far from well known. The problem is the more difficult because the several species and even varieties of plants respond in their own way. This fact is illustrated with striking clearness by the recent experiments which have been done with reference to photoperiodism, and the effects of temperature on growth and behavior. It has been the purpose of this discussion to restate and re-emphasize the desirability and absolute necessity of careful studies in plant nutrition which shall take into account the variable structure and composition of plants in relation to varied environments, and to use these as bases for practical recommendations. The task of finding out is a large one, but by no means too difficult. Future substantial progress will more than justify the effort. To know what a thing will do, it is necessary to know what it is, and is doing.

C.S.T.A. NEWS.

A meeting of the Quebec section will be held on September 2, at the Hotel St. Roch, Quebec. A dinner will precede a general discussion.

The following members of the Society read papers at the recent Toronto meeting of the British Association for the Advancement of Science: J. M. Swaine, G. P. McRostie, J. B. Reynolds, R. A. Fisher.

The Place of Minerals in Animal Nutrition.*

C. F. HUFFMAN

Michigan Agricultural College, East Lansing, Mich.

It is common information that animals need minerals as a part of their daily ration. The kind of minerals to feed and the amount required by different classes of live stock are questions upon which there is a diversity of opinion. The lack of knowledge regarding the mineral requirements of different farm animals accounts for the fact that they are not considered in the present day feeding standards. When farm animals were first domesticated the minerals found in the natural feeds were ample to meet the needs of the animal body. But to day the dairy cow produces many times as much milk as her early ancestors, and milk is high in minerals, especially lime and phosphorus. Then hen also produces many more eggs than did the hen of years ago, which means a marked increase in the mineral requirement. Beef cattle, sheep, and swine require more minerals for increased skeleton growth. Not only have the changed functions of our live stock increased the demand for minerals but the feeds of to day are often grown on soil depleted in the essential elements. Also many milled feeds and grains low in minerals are fed in order to increase the economic functions of our live stock. As a matter of fact the high producing dairy cows get most of their nutrients from concentrates and a fairly small per cent of the ration consists of roughages, while the natural diet consisted solely of roughages, the natural sources of lime and many other minerals. The hen is also fed an artificial ration. She no longer depends on grass, insects, worms, and pebbles for her ration, but is fed grains and mill by-products. The hogs have rings placed in their noses to prevent them from getting minerals and fresh protein; and in their place corn, middlings, etc., are fed which are low in minerals, especially lime. It is apparent that there is very apt to be a mineral deficiency in the ration of our live stock. At the present time the tendency is to make up this deficiency by growing crops rich in minerals and by feeding mineral supplements.

The one mineral supplement universally fed is common salt, which is required to a certain extent by all livestock. Salt furnishes sodium which is needed in the blood and chlorine which is used in making hydrochloric acid for the stomach. The salt requirement of carnivorous animals, such as the dog and cat, is very small compared with that of the herbivorous animals, such as the horse and cow. Swine and chickens, which live on both animal and vegetable foods, require less salt than those animals living entirely on herbage and more than those living entirely on animal food. According to Bunge, animals living on plants need more salt than those living on meat, due to the presence of so much potassium in vegetation which the salt helps eliminate from the system. However, a more logical explanation is that meat contains considerable chlorine and the ordinary natural plants are low in this element consequently less salt is needed where the ration consists of meat.

Live stock may be allowed free access to salt or they may be fed at regular intervals, or the salt may be mixed with the feed. Where salt is added to the grain ration of cattle, about one per cent is the usual amount added. Probable one-half of one per cent is ample for swine and chickens.

Iodine is an element needed by the animal body. A deficiency of this element results in goiter or "big neck" in calves and hairlessness in pigs. Iodine is often lacking in soils distant from the sea, and consequently goiter is more prevalent in such regions than near the sea coast. Decaying sea weeds liberate this element which is carried by the wind over the land and taken from the soil by the crops.

One of the functions of the thyroid gland is to make an iodine containing compound which aids in regulating different functions of the body. The addition of two grains

* Paper presented at the 4th Annual Convention of the C.S.T.A.

daily of either sodium iodide or potassium iodide to the ration of pregnant animals is ample to prevent goiter in the offspring. It is very difficult to mix such a small amount of dry sodium or potassium iodide with the ration. A more practical way is to estimate the salt consumption and mix the finely ground iodide with the salt. There should be a law in every country requiring a certain amount of iodide in all salt refined for human and animal consumption.

Several other minerals function in various ways in the animal body. Magnesium is often found in complex mineral mixtures in the form of magnesium carbonate, magnesium phophate and epsom salts. It is thought to possess a laxative property, stimulate the appetite, and aid in bone building. However, the addition of magnesium to the ration is probably not necessary since it is found abundantly in such feeds as cow pea hay, cottonseed meal, wheat bran, linseed oil meal, alfalfa hay and gluten feed.

Iron is necessary in the ration of live stock. The oxygen carrying power of the blood depends largely on the iron content. In certain countries a lack of iron in the soil causes a wasting away disease in cattle when they are pastured or fed crops grown on such soils. A similar disease has been produced experimentally in calves at the Michigan Agricultural Experiment Station. However, where the soil contains sufficient iron, the possibility of an iron deficiency is not great. Feeds, such as meat protein, most green stuff, wheat bran, and molasses contain sufficient iron to meet the needs of the animal body.

Sulphur in combination with protein is necessary for adequate growth and the formation of wool, hair, and feathers. It is found abundantly in gluten feed, cottonseed meal, linseed meal, soy beans, alfafa hay, and wheat bran. Many cattle showmen feed flowers of sulphur to their cattle because they believe that sulphur produces a smooth and slicker coat of hair and stimulates the functions of the skin. However, there is but very little scientific basis for such a belief. Experimental animals at the Michigan Agricultural Experiment Station receiving flowers of sulphur in the ration do not show as healthy skins and the hair is not as smooth as those not getting flowers of sulphur. It is doubtful if flowers of sulphur can be used by the animals in producing hair, but may have a beneficial effect on the digestive tract by controlling bacterial action.

Potassium is an element which is also necessary for growth, but it is not considered a limiting element in animal nutrition, since it is found abundantly in all roughages, soy beans, cottonseed meal, wheat bran, cow peas, linseed oil meal, milk, and meat. The addition of potassium to the mineral mixture is useless. Ordinarily lime and phosphorus are the limiting minerals in animal nutrition. Lime is necessary for the proper coagulation of the blood and also aids in regulating heart action and preventing some forms of tetany. Phosphorus is required for the manufacture of all nuclei and lipins which are present in all tissue and more abundantly in nervous tissue. The importance of these elements in the ration of growing animals is evident from the fact that 85% of the bone is made up of lime and phosphorus. Osborne and Mendel of Yale were unable to obtain normal growth in rats without an adequate supply of lime and phosphorus. Pearl of Maine found that the addition of lime to the ration of chicks increased the growth of the female birds. Our work at the Michigan Agricultural Experiment Station with dairy heifers indicates that it is extremely difficult to stunt the growth of the long bones of the body, but the short bones giving width failed to grow when a ration extremely low in lime was fed. Lime makes up from 1.5 to 2% of the weight of cattle and about 1% of the weight of swine. Phosphorus is present in slightly less amounts in both classes of live stock. Kellner estimated that a calf should receive two-thirds of an ounce of lime and one ounce of phosphorus daily in the ration. According to Orr and Husband of the Rowett Institute, Scotland, a calf gaining a pound a day requires two-thirds of an ounce each of lime and phosphorus in its ration. A pig making the same gain requires one-third of an ounce of lime and one ounce of phosphorus daily in its feed.

The importance of mineral supplements supplying lime and phosphorus for growth has probably been over emphasized. Our work indicates that animals can grow normally on natural foods low in lime, if plenty of the vitamin factor is present which aids in mineral retention.

The lime and phosphorus requirement of heavy producing dairy cows is very great due to the fact that milk is rich in these elements. The metabolism experiments of Forbes and others indicate that a high producing cow draws lime and phosphorus from her bones during the period of high milk production. Recent experiments, however, at the Wisconsin Experiment Station show that a high producing cow may be in positive lime balance providing she is fed a legume hay of good quality. Where timothy or mixed hay is fed there is apt to be a lack of lime in the ration, since most concentrates and roughages other than the legumes are low in this element. The possibilities of a phosphorus deficiency in the ration is less where grain is fed, since as a general rule concentrates are high in phosphorus and low in lime. Some of the ordinary feeds high in lime are tankage, cow pea hay, soy bean hay, powdered skim milk, alfalfa, and clover. Some ordinary feeds low in lime are hominy feed, rice, corn, wheat, oats, timothy hay, and wheat straw. Some feeds high in phosphorus are tankage, wheat bran, powdered skim milk, linseed oil meal, soy beans, cow pea hay, and whey, while those low in phosphorus are beet pulp, wheat straw, corn stover, rice, timothy, clover, and alfalfa.

A thousand pound cow producing 30 pounds of 4% milk daily, receiving alfalfa hay and a grain mixture containing cottonseed meal and wheat bran does not require additional lime and phosphorus in her ration as is shown in the following illustration.

Grain mixture	400 lbs. ground corn 400 lbs. ground oats 400 lbs. wheat bran 400 lbs. gluten (Buffalo) 200 lbs. cottonseed meal 200 lbs. linseed oil meal Digestible Protein 16.5%

Ration:

10 lbs. alfalfa
35 lbs. silage
8 lbs. grain (above mix.)

Lime in ration	80.7 grams
Lime required	69.0
Balance	11.7 grams
Phosphorus in ration	42.0 grams
Phosphorus required	39.0
Balance	3.0 grams

Ration for cow producing 60 lbs. of 4% milk daily using same grain mixture.

10 lbs. alfalfa
35 lbs. silage
17 lbs. grain

Lime ration	88.0 grams
Lime required	104.0
Balance	— 16.0 grams

If 1% of the grain ration had been calcium carbonate:

Lime in ration	119.0 grams
Lime required	104.0
Balance	15.0 grams
Phosphorus in ration	72.0 grams
Phosphorus required	70.0 grams
Balance	2.0 grams

The ration of high producing dairy cows is more likely to be deficient in lime than in phosphorus as is shown in the above example even where a legume is fed. This deficiency is much more marked where timothy hay is fed. The lime deficiency may be made good by the addition of calcium carbonate in the form of finely ground limestone rock, chalk or marl, providing sufficient of the mineral retention factor is present. Where the ration is deficient in both lime and phosphorus, acid phosphate, raw rock phosphate or special steamed bone meal may be added. Bone meal containing some tankage is the most palatable. A good mineral mixture is one-third steamed bone meal, one-third calcium carbonate and one-third salt. The salt increases the palatability of the mixture.

The same minerals may be fed to swine. However, where considerable tankage is fed to swine the need for mineral supplements is much less.

Recent work at the Kentucky Experiment Station indicates that bone meal aids in the growth of chickens but not in egg production. Oyster shell and limestone rock aided in shell formation and increased the number of eggs laid.

The ability of an animal to assimilate lime and phosphorus from the ration depends on the presence of a vitamin which aids in mineral retention. The ration may contain ample lime and phosphorus but they will not be retained unless this vitamin is present which may account for the negative calcium and

phosphorus balance obtained with dairy cattle in earlier metabolism experiments. The mineral retention vitamin is found abundantly in cod liver oil, all green stuff, and properly cured hay. The feeding of minerals to animals on pasture is recommended, due to the presence of this factor in green grass.

The amount of the mineral retention factor found in hay depends on the way in which it is cured. At the Wisconsin Experiment Station oat hay and alfalfa hay cured in cocks under canvas were much more effective in aiding retention than that exposed to sunlight. At the Michigan Experiment Station a left hand rake is used which rakes the hay as soon as it is cut and the hay is cured in the windrow with the butts sticking out and the leafy portion on the inside free from sunlight. Hay cured in this manner has a much greener appearance and probably contains more of the mineral retention factor.

The Relation of Mineral Supplements to Disease

The feeding of mineral supplements to live stock, especially cattle, sheep and poultry, is of value in counteracting toxic products produced when the ration consists largely of concentrates. For instance, leg weakness in young chickens can be cured or prevented by feeding calcium carbonate and the cure is brought about in a short time. Tetany in calves and lambs can also be combated by calcium carbonate, bone meal, or raw rock phosphate if these minerals are fed in large enough quantities.

Another function performed by certain mineral supplements is to keep up the alkaline reserve of the blood. Nature has placed in the blood stream certain minerals which act as buffers, neutralizing any acids which may get into the blood stream, thereby keeping the blood reaction constant. Cattle receiving a heavy grain ration have a much lower alkaline reserve than cattle receiving a sole diet of roughage. Acidosis is a condition where the alkaline reserve is abnormally low and is fairly common in the new born calves before ingestion of colostrum. Colostrum, which is rich in minerals as well as globulin causes a decided increase in the alkaline reserve of the blood of dairy calves.

The idea is prevalent that mineral supplements prevent or cure abortion. This idea is based on the famous Wisconsin experiment where the addition of calcium carbonate to the ration of the oat plant alone prevented abortion and resulted in the birth of normal calves. There is very little evidence which indicates that contagious abortion can be cured by mineral feeding. However, it is very likely that the addition of mineral supplements increases the resistance of the animal to disease by keeping up the alkaline reserve, by counteracting toxic products and by insuring proper lime and phosphate retention. Recently Meigs has found that the addition of calcium carbonate to a ration of grain and timothy hay reduced reproductive troubles.

Results at the Michigan Experiment Station indicate that depraved appetite in calves, which is manifested by a craving for things not classed as food, such as dirt, hair, bones, rags, etc., is not due to a mineral deficiency in the ration, but due to the lack of a factor found in cod liver oil.

Minerals in the form of calcium carbonate, raw rock phosphate, bone meal, acid phosphate, wood ashes, and a mineral mixture similar to that found in alfalfa hay does not prevent or cure depraved appetite in calves.

Depraved appetite in calves may be cured by feeding two ounces of cod liver oil daily for about a week. This condition does not often occur when the animals are on pasture or receiving hay of good quality.

C.S.T.A. NEWS.

G. H. Cutler, Professor of Field Husbandry at the University of Alberta, has obtained a year's leave of absence for the purpose of taking post graduate work at the University of Wisconsin. Professor Cutler has resigned his Chairmanship of the Finance Committee of the Society.

L. T. Chapman, Secretary of the Alberta Branch of the Society, has been appointed Assistant at the Dominion Experimental Station at Lacombe, Alberta.

Fred H. Grindley, General Secretary of the Society, is enjoying a vacation in the British Isles.

The Progress of Agriculture on a New Brunswick Farm During Four Generations.

R. P. GORHAM

Fredericton, N.B.

Many New Brunswick farms have passed from father to son through several generations, each in turn dropping some of the practices of the preceding and adopting others in accord with the progress of the period in which they lived. Each generation thus represents an era in the history of that farm and may be regarded as a unit for an historic view of the progress of agriculture through the period since the settlement of the country. A recent study of the history of one parish has shown that in the period between settlement in 1783 by Loyalists and 1924, there have been on the different farms between three and six generations of people, varying in different families. Only one instance of a three generation farm was found, many of four and five and a few of the sixth generation. For the purpose of this article a four generation farm has been selected as generally typical of the conditions of the region and one with the history of which the writer is well acquainted.

This farm was granted in 1784 to a Loyalist who had been driven off his Connecticut farm during the Revolutionary War, had made a living for himself and family by cutting wood and other employment with the army during the last years of that struggle and had been one of the many who immigrated to the River St. John, Nova Scotia, in 1783. He was born in 1750, and married just at the beginning of the war. When he arrived at the mouth of the St. John in 1783 he had with him his wife and two small daughters.

The country was then a wilderness with forest occupying a large part of the site of the present St. John City. A lot was granted to him in the proposed town plot and 500 feet of boards. With logs and boards a shelter was erected which protected the family through the first winter. The next spring a forest fire swept part of the site of St. John, destroying along with those of others, his house together with most of its meagre contents. In July of that year 1784 he received the grant of his farm lot and moved on to it at once in time to get a log house erected before winter. Thus we have the beginning of a farm history and the conditions under which a man, woman and two children began life on a New Brunswick farm.

The country was densely forested. Clearing land and making roads took years of labor and throughout the life of this generation all crops were grown among blackened stumps. The first roads were blazed trails from farm to farm and to the village site where church and school were erected. No horses or oxen were available for the first two years and all moving of logs for building, and the breaking of the soil for crops had to be done by muscular effort of the men of the district working together. The young wife died before roads were made and although the church and burial ground had been established at the village, five miles distant, she had to be buried on her husband's farm as were many others of the Loyalist wives and mothers. The man was on the farm with two small children for two years and then married a second time and had other children.

The living conditions of the first generation were hard, scanty flour supply from England at first, later from their own wheat, scanty milk supply for two years or more, no roads, except the river ice in winter, mail three times in the summer and once in winter, the loghouse and open fireplace. The progress they made was the clearing of land, growing of wheat and vegetables, the fencing of fields to keep animals in when they obtained them, the making of roads, the establishment of an ordered system of government with rigid laws for those who broke the rules of civil conduct, the building of a church which stands today a monument to their industry, the establishment of parish

and grammar schools. If the life was hard it was healthful and most of the Loyalists were long on the land; the one of whom we write closed his active life in 1843. There are still several old people alive who remember him well and can describe his appearance and habits so that even yet we have not lost touch with the Loyalists by the spoken word.

The eldest son, of the second generation assumed the management of the farm in 1820, under the direction of his father. His was a lumbering generation when shipbuilding and the sale of lumber to European countries brought in a cash return from the waste of clearing land which the first generation did not have. Many acres were cleared, crops were extensively grown among the stumps, farm animals multiplied, two yoke of oxen were reared and farm labourers were employed. Produce was taken to market twenty-five miles distant by row boat at first, later this generation had the advantage of the first river steamers. Mails arrived at the village every week, books were more common, the first oil lamps were in use, the iron cooking stove had appeared in some homes, the Franklin stove in others. Roads were passable for wheeled vehicles and church was regularly attended as were many balls and social parties. On the farm the growing of wheat had been dropped, due to insect ravages, and buckwheat substituted, while the wheat flour was imported from other countries. This generation saw also the building of the first railroads. 1880 saw the close of the second generation on the farm with the third well along in the management under the parents' direction.

The farmer of the third generation was the youngest son of a family of seven and as such had in youth gone out to see something of the world away from home. The shipping boom was at its height in his youth and attractive to many of the young men of that period. As a sailor he visited various countries and took the opportunity to travel over parts of England and Scotland. Next he went to the Australian gold fields for a few years, then home on a visit and back to Australia for four years of farm work. He returned to New Brunswick to care for his parents and assumed the management of the home farm in 1860. From Britain be brought the plan of underdrainage and use of lime, from Australia the use of farm machinery in handling hay and grain, from the United States the growing of fruit for market. The orchard planted was the first commercial one in the county. Oxen were discarded for horses in farm work, a mower was imported to replace the scythe, more livestock and of a better grade was kept, commercial fertilizers were used and for their cooperative purchase the agricultural society was organized, rotation of crops and the growing of the swede turnip for live stock feeding were introduced and spread rapidly through the region. This generation saw the introduction of the electric light, telephone and street car in the cities, the cheapening of transportation by river steamer, the improvement of the mail service to twice weekly, better roads, the discarding of buckwheat as a crop and the introduction of market gardening including small fruits to supply the needs of the cities. In the home, weaving and spinning were dropped, cooking ranges and the washing machine introduced, better lighting provided and the first hardwood floors laid. The close of the 19th century saw the close of the third generation which was one of marked progress in all lines having to do with agriculture and the home.

The fourth generation has been operating the farm since 1901. The changes in agricultural practice have not been great in so far as crops grown are concerned but the methods of handling those crops have changed radically. The hand hoe used by the preceding generations has largely given place to the horse driven cultivator, mechanical aids have been introduced in nearly every stage of farm activity for planting, cultivation and harvesting. The potato, hay and grain crops, most laborious to the earlier generations are now managed with ease. Sprays and dusts for the control of insects and diseases are now regularly applied on the principle of prevention. They add to the cost of production a greater amount than the earlier generations would have considered justifiable, but provide insurance against the great losses sometimes sustained in earlier years. Fertilizers are better known and special mixtures are made up for special crops from raw materials purchased cooperatively, legumes are grown in every rotation and seed inoculation practised.

No less important have been the changes in the home and social life. The organ of the third generation has given place to the piano, the fireplace of the second and heater stove of the third generation to the basement furnace. The children have gone to school in a covered van and secured each a High School training. Three daughters are now graduate teachers. The mail is delivered daily by the rural carrier. The farmer is manager of a rural telephone company employing several people in the central and serving a large area. He goes to church and social functions in a motor car over gravelled roads and several times a year attends conventions and meetings of other farmers in different parts of his home province and puts his thought into resolutions and recommendations to the Legislature for the government of the country. In contrast to the four mails a year of the first generation the farmer of the fourth, when work is done for the day, listens by radio to the world's news, market reports from Pittsburg, or Schenectady or Chicago and the best music of Montreal and Boston. He is not wealthy but has a home free from debt, a contented family and a son to continue the work of the farm in later years. This is the progress of four generations on one New Brunswick Farm.

An objection may be raised that the foregoing is not typical of all farms. It is true that there are many more progressive and some less so than the one described, but a critical survey of the region shows that on every farm, even the very poorest, will be found many of the marks of the progress of the period and generation. More than one-half the farmers of the district now own motor cars and get around to see what others are doing. In the poorest home will be found the sewing machine, modern cooking equipment and some form of musical instrument, and on the farm the poorest farmer is not using more than one or two devices or practices which belonged to the previous generation. A grammar school has been in operation for more than seventy years and there are few farmers in that region who have not the equivalent of a High School training. A consolidated school with vans for the conveyance of children has been in operation for twenty years and now numbers among its graduates sixteen who have taken one or more university degrees, and double that number of trained teachers and nurses. The farms are rough, rocky and hard to operate but they support a sturdy people whose ancestors were residents of Connecticut before the Revolutionary War and had made the name of Connecticut Yankee a hallmark of progress and enterprise even before that time. Their descendants on New Brunswick farms have maintained in large degree the standards of those Loyalists who built the old church on Kingston Hill in which their great grand children worship today, the oldest Anglican Church in the province.

Present Day Problems in Crop Production.*

SIR E. JOHN RUSSELL, F.R.S.,

President of the Agricultural Section, British Association for the Advancement of Science.

The visits of the British Association to Canada have hitherto very appropriately coincided with definite stages in the progress of agricultural science and practice. It was at the Montreal meeting of 1884 that Lawes and Gilbert presented their well-known paper on the sources of the fertility of Manitoba soils which ended the first great period of the development of agricultural science. This period had lasted eighty years; it had been ushered in with the precise and scientific work of de Saussure published in 1804; its outstanding features had been the foundation of agricultural science by Boussingault in 1834, its enrichment by Liebig's brilliant essay of 1840, and its systematic development by Lawes and Gilbert at Rothamsted from 1843 onwards. The whole purpose of the scientific workers of the period was to feed the plant; in Gilbert's own words the message of the crops on the Rothamsted plots

* Address of the President, at Toronto, 1924.

as, 'If you won't feed us we won't grow.' he success of the new science was remarkble; its great triumph was the discovery of rtificial fertilisers and their introduction in farming practice, and the workers had the reat joy of seeing the crop yields rise conderably as the direct and recognized result f their labours. The problems were largely hemical, and agricultural science was rearded as simply a branch of chemistry. Gilert's paper in 1884 was read before the Chemical Section and it presented soil fertilty as essentially chemical; a fertile soil, he rgued, is one containing much plant food, specially nitrogen; it is one which has acumulated within it the residues of ages of atural vegetation, and it becomes infertile s this residue is exhausted.' At the time of he Toronto meeting in 1896 a new period ad begun, quietly and unnoticed, but growth vas so rapid that at the Winnipeg meeting in 909 the subject had grown right away from hemistry; it had become a definite subsecion, and its importance was so widely reognised that a recommendation was passed sking the Council to set it up as a full secion, which was subsequently done.

In this second period the purpose was not o feed the crop but to study it; to discover vhat factors are concerned in the growth of rops and how they operate. This period, vhich may be called the period of free exloration, since the workers were not usually ied down to any particular technical probem, began almost simultaneously in the Unit-d States, in France, and in Germany. As oon as agricultural science was studied in he United States it became evident that the ultivation of the soil was at least as importnt as the feeding of the crop. This fact had f course been fully recognized in the English xperiments, but the English farmer was so killed in cultivation that he could be taught ut little by science. The early American vork as developed by Kedzie at Michigan, King at Wisconsin, Hilgard, and Whitney, vas largely physical, and it greatly widened he outlook of agricultural investigators, openng the way to the extensive physical and hysico-chemical studies which have now beome so characteristic a feature of American vork. The French investigators, particularly chloesing, Muntz, Berthelot, and Déhérain, nd the brilliant Russian, Winogradsky, then n Paris, revealed a new world of soil microorganisms, the wonder and mystery of which appealed to the imagination of the younger workers in a way that none of the older utilitarian work had done. The Germans methodically explored the fields thus opened up; Hellriegel and Wollny accumulated a mass of data as to plant growth and soil changes which still remains of value to the student. These pioneers were succeeded by a host of followers whom it would be impossible to enumerate at length, and from whom it would be invidious to select a few. Moreover, the chemists and physicists of the old school were no longer left in sole possession; van Bemmelen introduced the conception of colloids, and at a later date Mitscherlich, Baule, and others developed the idea of mathematical expressions for the data of agricultural science. Sachs and his pupils in Germany, Déhérain, Maquenne and Demoussy in France, joined up the new science of plant physiology with agricultural science. The plant breeder also came in; Gregor Mendel's work, after lying hidden for forty years, was revealed to the world by Bateson and was at once turned to agricultural use in England by one of Marshall Ward's pupils, R. H. Biffen; and in the United States by Webber and others. The selection method was developed to a high pitch of perfection in Canada by William Saunders, a revered leader in our science; whose dignified presence and kindly words of greeting remain as a vivid recollection of our visit fifteen years ago. His mantle has fallen on his son Charles, who has continued and developed the work.

The result of all this effort has been the accumulation of an enormous mass of information covering a very large part of the field with which agriculture has to deal. It has been essentially a pioneer period, with all the advantages of keen individual interest, controversy, sometimes even of excitement; but also with the disadvantages of a certain lack of perspective, failure to follow up important issues and some narrowness of outlook inevitable when a single individual is working alone at a great subject.

Generalisations that have Emerged.

But in spite of these drawbacks several important generalisations have emerged. One of the most pregnant in possibilities for the future is the recognition that the plant is

a very plastic organisation and can be modified to a considerable extent within certain limits. Two methods are adopted: breeding, which may be on observational lines or on the Mendelian method of picking out the desired unit characters from plants in which they occur and assembling them in a new plant; and selection, in which a desirable plant is caused to produce seed from which stocks are multiplied. The scientific problems fall within the province of the science of genetics; the practical significance of the work lies in the fact that it greatly simplifies the agricultural problem by providing plants more or less suitable to the difficult, if not impossible, task of making the conditions suit the available plants. The work has proved extraordinarily fruitful and has given astonishing results even in our own time. It has played no small part in the amazing development of wheat growing in Canada. When the British Association went to Winnipeg in 1909 we were all impressed by the fact that Canada had then passed the 160-million bushel mark in production, but who would have thought that within fourteen years the production would exceed 474 million bushels? Even in England, where wheat has been grown for 2,000 years, and where farmers have a long traditional knowledge of the crop, the new varieties introduced by Biffen have increased the yields and the certainty of yields. The triumphs of Webber and others in the United States, of Nielson Ehle with cereals in Sweden, Jeffrevs in standardising the quality of cotton in Egypt, the Howards in producing wheats for India, to mention only a few, are still fresh in our minds. In the first period in the development of agricultural science the honours in the matter of practical applications lay with the chemists for the artificial manures, but in the present period we must admit that they lie with the plant breeders and selectors who, indeed, are only on the threshold of what they may yet accomplish. And this great practical purpose of finding or producing varieties of crops especially suited to local conditions would be further advanced if the work were done in co-operation with plant physiologists who could precisely define the modifications required. Much saving of time and effort could be effected if it were possible to set up some International garden where small quantities of the plant breeders' productions could be grown, including those which each one has received as being unsuitable to his particular requirements. Many of these unwanted outcasts might prove of value in other conditions.

A second generalisation is that the soil is not a fixed, constant thing, but is pulsating with change. It contains a great population of microorganisms which, among other activities, decompose the dead plant residues, producing nitrates, humic and other substances of great importance in crop production. But the number of these organisms fluctuate continually, and the bacteria at least change hourly; the nitrates suffer equally rapid changes in amount. Even the mineral part of the soil is not constant in composition. Modern research work shows that many of the properties determining fertility in soils are due to the soil colloids, and some of the most important are attributed to calcium complexes. These are unstable and are affected by the soil water. If the water is free from salts but contains carbon dioxide, the calcium may be replaced by hydrogen, and an acid soil results; if the water contains sodium chloride, the calcium is replaceable by sodium and the resulting complex may readily give rise to an alkali soil. So far as is known, the changes are governed by the ordinary stoichiometric laws, the equilibrium following the usual course expected when a colloid is concerned. But the important fact emerges that any soil not well supplied with calcium contains within itself the possibility of becoming acid and therefore infertile, or alkaline and probably sterile, according to the nature of the soil water soaking through it. The various biological and chemical changes tend to alter the composition of the soil solution. Apparently, however, the colloids have a steadying or 'buffering' effect reducing the degree of acidity by the production of acids and absorbing or precipitating various ions that might otherwise cause disturbances.

A third important generalisation that has emerged is that the relations of the plant and the soil are not rigidly fixed but are capable of considerable variation, being profoundly influenced by a third factor, the climate. A soil moderately fertile in one set of conditions may be relatively unproductive in another. This happens repeatedly with soil

ntaining much clay or much coarse sand. Table I. are given the mechanical analyses two soils, one of which, the Lias clay from gland, is quite unworkable and remains relict under our conditions of cool tempera- e and moderate but frequent rainfall, by ason of its high content of clay and fine ; while the other, which contains even re clay, is capable of carrying good crops grain and cotton under the hot dry condi- ns of the Sudan. The Western prairie soil of similar physical type to that of the English Weald soil, but while the prairie soil under its climatic conditions of warm dry summer and cold dry winter is, and is likely to remain, a fertile wheat producer, the Weald soil under the wetter conditions of England is less fertile. In hot dry conditions the clay is no disadvantage and may even be an advantage, but in wet conditions it becomes a serious drawback; indeed, it might be possible to find some mathematical relationship between rainfall and degree of objectionableness in clay.

TABLE I.

oils of similar type as regards mechanical analysis. but varying greatly in fertility by reason of climatic conditions.

	Rich in finer fractions				Rich in coarser fractions	
	Waste land very difficult of cultivation	Fertile soil, millet and cotton	Poor farm land difficult to cultivate	Good prairie soil, Wheat	Waste land, Norfolk	Market garden, Anglesey
	Lias clay Oxfordshire	Sudan	Weald clay, Kent	Brandon	22 in. rain	35 in. rain
e sand. 2.0 to 0.2 mm..	0.7	7.6*	1.5	2.5	62.4	93.7
sand, 0.2 to 0.04 mm..	2.0	20.9	11.0	15.4	25.7	2.8
0.04 to 0.01 mm.	6.4	12.6	19.6	17.7	0.2	0.5
silt, 0.01 to 0.002 mm..	22.0		26.8	16.1	1.8	0.4
(below 0.002 mm.)	41.0	55.9	22.1	29.2	0.6	Nil

* Mainly black nodules of calcium carbonate.

It appears then that if a fertile soil were ried from one country to another its pro- tive power would not necessarily be car- d with it. Its fertility is, to a consider- e extent, dependent on the fact that it fits with the climatic factors in producing ditions favourable to good growth of irable crops.

mplexity of the Problem: Methods of Attack.

The agricultural investigator is thus con- nted with three closely interlocking agen- s—the plant, the climate, and the soil— h of which is variable within certain its, and each playing a large part in the p production which it is his business to dy.

Confronted with a problem of this degree complexity there are two methods of pro- ure: the empirical method of field obser- vations and experiments, in which there is no pretence of great refinement and no expectation that the same result will ever be obtained twice, it being sufficient if over an average of numerous trials a result is obtained more often than would be expected from the laws of chance; and the scientific method, in which the factors are carefully analysed and their effects studied quantitatively; a synthesis is then attempted, and efforts are made to reconstruct the whole chain of processes and results. The scientific method is, of course, the one to which we are naturally attracted. But common truthfulness compels one to admit that up to the present the greatest advances in the actual production of crops have been effected by the empirical method, and not infrequently by men who are really artists rather than men of science, in that they are guided by some intuitive process which they cannot explain, and that they have the vision

of the result before they obtain it, which the scientific man commonly has not.

The best hope for the future lies in the combination of the empirical and the scientific methods. This is steadily being accomplished by the recent strong infusion of science into the art of field experimentation, which has enhanced the value of the field work and the trustworthiness of its results. Modern methods of replication, such as have been worked out at Rothamsted, and in the United States by Harris of the Carnegie Trust (Cold Spring Harbor), Kiesselbach in Nebraska, Myers and Love of Cornell, and others, constitute a marked improvement in plot technique. And the figures themselves, besides being more accurate, can be made to yield more information than was formerly the case.

Great advances have been made in the methods of analysing the results. The figures are never the same in any two seasons, since the climatic conditions profoundly affect the yields. A few men, like J. H. Gilbert, have the faculty of extracting a great deal of information from a vast table of figures, but in the main even the trained scientific worker can make very little of them. The reason is that he has been brought up to deal with cases where only one factor is varying, while the growth of plants involves the interaction of three variable factors: the plant, the soil, and the climate. It is impossible to apply in the field the ordinary methods of the scientific investigator where single factors alone are studied; very different methods are needed, adapted to the case where several factors vary simultaneously.

Fortunately for agricultural science, statisticians have in recent years worked out methods of this kind, and these are being modified and developed by R. A. Fisher and Miss Mackenzie for application to the Rothamsted field data. It so happens that this material is very suitable for the purpose, since a large number of the field experiments have been repeated every year for seventy or eighty years on the same crop and on the same piece of land, using the same methods; the field workers also remain the same for many years, the changes being rare and without break in continuity. Although the statistical investigation is only recently begun, mathematical expression has already been given to the relationship between rainfall and yield of wheat and barley under different fertiliser treatments, and precision has been given to some of the ideas that have hitherto been only general impressions. If on an average of years a farmer is liable to a certain distribution of rainfall, it is becoming possible to advise as to fertiliser treatment which enables the plant to make the best of this rainfall.

Unfortunately, few other Experimental Stations possess such complete masses of data as Rothamsted. Methods are now being devised, however, both by Fisher and by the able English investigator who modestly conceals his identity under the pseudonym 'Student,' for the study of smaller numbers of data, and it is hoped that these or other equally effective will be applied to the results of field experiments accumulated at various Experimental Stations throughout the world. A massed attack by a competent band of statisticians on the whole of the data of the best Experimental Stations, dealing with yields of crops under different conditions of nutrient supply, temperature, rainfall and other factors that go to make up the aggregate called season, would yield information of extraordinary value.

Investigations of this kind, however, are necessarily slow, and they do not themselves afford complete information; their value lies in the fact that they reduce a very complex problem to a set of single-factor problems of the type with which the scientific investigator is already familiar. In the meantime, while this work is proceeding, much is being done by observational methods. At Rothamsted the field plots are under continual observation by a group of three workers, a physiologist, an ecologist, and an agriculturist, who study such factors as rate of habit of growth, earliness of starting or maturing, degree of resistance to insect or fungus attack; their observations are fully recorded and brought before the chemical, physical and botanical departments at regular and frequent intervals. Certain of the experiments are repeated at other centres on closely similar lines for purposes of comparison. In consequence our old field plots which have been studied for the past eighty years by Lawes, Gilbert, Warington, and Hall

ıd might have been supposed to have no ırther tales to tell, are found to be still elding results of great interest in agricul- ral science and practice.

The Results Obtained: Alterations in the Plant.

We shall begin with the results obtained y effecting alterations in the plant. Refer- ıce has already been made to the changes rought about by the plant breeder, and we eed not stop to argue whether the great nprovements in crops made in pre- lendelian days by the Suttons and Findlay potatoes, by Chevalier in barley, by the artons in oats, Vilmorin in sugar beet, and hers, should be labelled empirical or scien- fic. There are certain other changes in lants, however, of a purely temporary na- ıre, which have been induced by changes conditions. It is a commonplace among ırmers that certain soil conditions influence ot only the yield but also the quality of ops. The leaf and root are more easily fected than the seed. The case of mangolds as been investigated at Rothamsted; the ıgar content of the root, an important fac- r in determining feeding value, was in- eased by increasing the supply of potassium the crop. Middleton at Cockle Park show- d that grass increased in feeding value— uite apart from any increase in quantity— hen treated with phosphates. Potatoes are onsiderably influenced by manuring; in- easing the supply of potassium influences ıe composition of the tubers and also that uch more impalpable quality—the cook's stimate of the value of the potato; while e have found at Rothamsted that a high-class ook discriminated between potatoes fertilised ith sulphate of potash and those fertilised ith muriate of potash, giving preference to e former.

Grain is more difficult to alter by changes environmental conditions; indeed, it ap- ears that the plant tends to produce seed of bstantially the same composition what- er its treatment—with the important ex- ption of variation in moisture supply. Dr. ıutt has explored the possibilities of alter- g the character of the wheat grain by vary- g the soil conditions, and finds that in- eases in soil moisture decrease the nitrogen the grain. Similar results have been ob- ined in the United States.

On the other hand, in England the reverse seems to hold, at any rate for barley. This crop is being fully investigated at the present time under the Research Scheme of the Institute of Brewing, because of its importance in the preparation of what is still Britain's national beverage. Increased moisture supply increases the percentage of nitrogen in the grain, and so also does increased nitrogen supply, though to a much less extent; on the other hand, both potassic and phosphatic fertilisers may decrease the percentage of nitrogen, though they do not always do so; the laws regulating their action are unknown to us.

The practical importance of these problems of regulating the composition of the plant lies in the fact that the farmer can control his fertiliser supply, and also to some extent his moisture supply, so that it lies within his power to effect some change should he wish to do so.

The following are the nitrogen contents and the valuations of barley grown in the same season from the same lot of seed on farms only a few miles apart:—

EFFECT OF MOISTURE.

	Drier soil	Moist land
Nitrogen per cent. in grain..	1.44	1.80
Valuation per quarter of 448 lb.	52s. 5d.	41s. 6d.

EFFECT OF NUTRIENTS.

	No nitrogenous manure	Nitrogenous manure
Nitrogen per cent. in grain ...	1.379	1.464
Valuation per quarter of 448 lb..	53s.	52s.

At present we know but little about the matter and we are not in a position to advise the farmer as to how he may use these facts to the full advantage. The complete study of the problem necessitates the co-operation of a plant physiologist.

There is another direction also in which alterations in the plant would be of great value if only we knew with certainty how to bring them about.

In agricultural science one sometimes thinks only of the crop and the factors that affect its growth. But in agricultural practice there is often another partner in the concern: a pest or parasite causing disease. The amount of damage done by pests and diseases to agricultural crops is astounding; in Britain it is probably at least 10 per

cent. of the total value of the crops and the loss is probably some 12,000,000*l.* sterling per annum; in some countries it is considerably more. Indeed, the number of insect pests and of harmful fungi and bacteria that skilled entomologists and mycologists have found in our fields might almost lead us to despair of ever raising a single crop, but fortunately the young plant, like the human child, grows up in spite of the vast number of possible deaths. The saving fact seems to be that the pest does harm only when three sets of conditions happen to occur together: the pest must be present in the attacking state; the plant must be in a sufficiently receptive state; and the conditions must be favourable to the development of the pest. It is because this favourable conjunction of conditions comes but rarely that crops manage to survive. And this gives us the key to control if only we knew how to use it. Complete control of any of these three conditions would end all plant diseases. Unfortunately, control is never complete even in glasshouse culture, still less out of doors. But even partial control would be very helpful. All these pests go through life cycles, which are being studied in great detail all over the world, and especially in the United States. Somewhere there occurs a stage which is weaker or more easily controlled than others, and the pest would become harmless if the chain could be broken here or if the cycle could be sufficiently retarded to give the plant a chance of passing the susceptible stage before it is attacked.

The plants themselves, as we have just seen, are in some degree under control, and if they could be pushed through the susceptible stages before the pest was ready they would escape attack. Barley in England is sometimes considerably injured by the gout fly (*Chlorops toeniopus*). The larvae emerge in spring from the eggs laid on the leaves and invariably crawl downwards, entering the young ear if, as usually happens, it still remains ensheathed in leaves. J. G. H. Frew, at Rothamsted, has shown that early sowing and suitable manuring cause the ear to grow quickly above the track of the larvae, and thus to escape injury. E. A. Andrews, in India, has found that tea bushes well supplied with potassic fertiliser escape attack from the mosquito bug (*Helopeltis*) for the rest of the season, apparently because bushes so treated become unsuitable as food to the pest. And further, the conditions are alterable. H. H. King, in the Sudan, has effected some degree of control of the cotton thrips (*Heliothrips indicus*) by giving the plant protection against the drying North wind and so maintaining a rather more humid atmosphere—a condition in which the plant flourishes more than the pest. Tomatoes in England suffered greatly from *Verticillium* wilt till it was found that a small alteration of temperature threw the attack out of joint. They are also much affected by stripe disease (*B. lathyri*), but they become more resistant when the supply of potash is increased relative to the nitrogen. It has recently been maintained, though the proof is not yet sufficient, that an altered method of cultivating wheat in England will afford a good protection against bunt. These cultural methods of dealing with plant diseases and pests offer great possibilities, and a close study jointly by plant physiologists and pathologists of the responses of the plant to its surroundings and the relationships between the physiological conditions of the plant and the attacks of its various parasites, would undoubtedly yield results of greater value for the control of plant diseases. Again, however, the plant breeder can save a world of trouble by producing a variety resistant to the disease; or there may fortunately be found an immune plant from which stocks can be had, as in the case of the potatoes found by Mr. Gough to be immune to the terrible wart disease.

Control of Environmental Factors.

It thus appears that, if only plant breeders and plant physiologists could learn to alter existing plants or to build up new plants in such a way that they would be well adapted to existing soil and climate conditions, and not adapted to receive organisms at the time the organisms are ready to come—if only they could do this all agricultural land would become fertile and plant diseases and pests would become ineffective: at any rate until the pests adapted themeslves to the new plants. Although no one can set limits to the possibilities of plant breeding and plant physiology, we cannot assume that we are anywhere near this desirable achievement or that we are likely to be in our time. There will always remain the necessity for alterin

ne environmental conditions to bring them loser to the optimum conditions for the rowth of the plant. No attempt is yet made n the field to control two of the most import- nt of the factors: the light and the tempera- ure, though it is being tried experimentally. here is a great field for future workers here; t present plants utilise only a fraction of ne radiant energy they receive. At Rotham- ted attempts have been made by F. G. Gre- ory to measure this fraction; the difficulties re considerable, but the evidence shows that ur most efficient plants lag far behind our vorst motor-cars when regarded as energy ransformers for human purposes. One hund- ed years ago the efficiency of an engine as ransformer of energy was about 2 per cent.; ow, as a result of scientific developments, it s more than 30 per cent. To-day the efficiency f the best field crops in England as trans- ormers of the sun's energy is about 1 per ent.[1]: can we hope for a similar develop- nent in the next hundred years? If such an ncrease could be obtained an ordinary crop f wheat would be about 400 bushels per cre, and farmers would feel sorry for them- elves if they obtained only 200 bushels. But we are only at the beginning of the sub- ect. Increases in plant growth amounting o some 20 or 25 per cent. have been obtain- d by V. H. Blackman in England under the nfluence of the high-tension electric dis- harge, which presumably acts by increasing n some way the efficiency of the plant as an nergy transformer. Possibly other ways ould be found. It needs only a small change n efficiency to produce a large increase in ield. Much could be learned from a study f the mass of data which could be accumulat- d if agricultural investigators would express heir results in energy units as well as in rop yields as at present.

Interesting results may be expected from he attempts now being made in glasshouse ulture both in Germany and at Cheshunt to ncrease the rate of plant growth by increas- ng the concentration of the carbon dioxide n the atmosphere.

Control of the Soil Factors.

The soil factors lend themselves more read- ly to control and much has been already achieved. Water supply was one of the first to be dealt with. Civilisation arose in the dry regions of the earth, and as far back as 5,000 years ago irrigation was so advanced as a practical method that it came into the ordinances drawn up by the great Babylonian king Hammurabi. The chief problems at the present time are to discover effective means of economising water and to ascertain, and if possible control, the relationships between the soil, the water, and the dissolved sub- stances in the water. Economical use of water is necessary because it allows larger areas to be irrigated, and because water be- yond a certain amount injures the soil and asphyxiates the plant roots. This part of the problem is largely one of engineering and police control. The more serious prob- lem, perhaps the most serious confronting agricultural science to-day, is that presented by the soluble matter in the water and the soil. The terrible spectre of alkali looms ahead of every irrigation project; it may be kept under control for a longer or shorter time or it may completely wreck the scheme. Instances could be multiplied of schemes started with great expectations of results yet yielding only disappointment and loss. A volume could be filled with the tragedies of the alkali problem. Neutral salts, particular- ly sodium sulphate, are not harmful to plants unless their concentration exceeds a certain critical value; indeed, some of the heavy soils in dry countries, as in Egypt and the Sudan, become unworkable if washed with pure water; they remain flocculated only because some soluble salts are present. Chlorides beyond a critical concentration are more harmful to the plant, but sodium carbonate is deadly, and there is no certain way at pre- sent of overcoming its effects.

The empirical method has apparently gone as far as it can, and nothing more can be expected until some fresh opening is dis- covered by scientific workers.

Almost equally important is the more ef- ficient utilisation of water in districts where the rainfall is sufficiently high to obviate the need for irrigation, but insufficient to allow of any wastage of water. The practical work of the Utah agriculturists as exemplified by Widstoe, and the laboratory results of Keen

[1] The remaining energy being largely used up n transpiration. This figure refers to the total adiation received by the leaf, and not to the raction received by the chloroplast surface. For his latter the value is much higher.

at Rothamsted, all indicate that something can be done. It is legitimate to hope that the next great advance will come from Canada, where in the West there are admirable opportunities for studying the problem.

Inseparably bound up with water supply are the questions of cultivation and of drainage, which affect not only the water but the air supply to the roots. This former subject is now attracting considerable attention: the great need is to discover means for expressing cultivation in exact physical and engineering units. The measurements of Keen and Haines at Rothamsted, and the chemical work of A. F. Joseph, N. Comber and others on clay, and of Odén, Page, and others on humus, indicate the possibility of finding exact expressions and of effecting co-operation with the workers in the new fields of agricultural engineering.

Another soil factor which readily lends itself to some degree of control is the amount of plant nutrients present. The possibility of increasing this by means of manure has been so frequently explored in field trials that it has sometimes been regarded as almost a completed story; indeed, Rothamsted tradition affirms that Lawes himself once gave orders to have the Broadbalk field experiments discontinued because they had nothing further to tell; it was only the earnest persuasion of Gilbert that caused him to countermand the order. So far from the subject being exhausted, it still bristles with problems. The new nitrogenous fertilisers, resulting from war-time activities in nitrogen fixation; the need for reducing the cost of superphosphate; the change in character of basic slag; and the Alsatian development in potash production are producing changes in the fertiliser industry the full effects of which are not easy to foresee. Economic pressure is driving the farmer to derive the maximum benefit from his expenditure on fertilisers, lime, farmyard manure and other ameliorating agents, and is compelling a more careful study of possibilities hitherto disregarded, such as the use of magnesium salts, silicates, and sulphur as fertilisers, and, above all, a much more precise diagnosis of soil deficiencies than was thought necessary in pre-war days.

But there are more fundamental problems awaiting solution. It is by no means certain that we know even yet all the plant nutrients. The list compiled by Sachs many years ago includes all needed in relatively large amounts, but Gabriel Bertrand has shown that it is not complete and that certain substances —he studied especially manganese—are essential, although only in very small amounts. Miss Katherine Warington, working with Dr. Brenchley at Rothamsted, has shown that leguminous plants fail to develop in the so-called complete culture solution unless a trace of boric acid is added. Mazé has indicated other elements needed in small amounts.

Another problem needing elucidation is the relationship between the quantity of nutrients supplied and the amount of dry matter produced. Is dry matter production simply proportional to nutrient supply, as Liebig argued, with the tailing off beyond a certain point, as demonstrated by Lawes and Gilbert, or is it always less than this, as indicated by Mitscherlich's logarithmic curve, or is the relationship expressed by one of the more complex sigmoid curves as there is some reason to suppose? We do not know; and the problem is by no means simple, yet it governs the 'diminishing returns' about which farmers now hear so much. Again, very little is known of the relationship between nutrition and period of growth. One and the same quantity of a nitrogenous fertiliser, for example, may have very different effects on the plant according as it is given early or late in life; not only is there a difference in quantity of growth, but also in the character of the growth. Late dressings cause the characteristic dark-green colour to appear late in the season, and thus affect the liability to fungoid diseases; they increase the percentage of nitrogen in the grain and they may give larger increases of crop than early dressings.

Investigations are needed to find the best methods of increasing the supply of organic matter in the soil and its value for the different crops in the rotation.

(*Continued in next issue.*)

Dusts and Dusting in Crop Pest Control.*

A. KELSALL

Dominion Entomological Laboratory, Annapolis Royal, N.S.

Introduction

Dusting for the control of plant pests both ect and fungous has come into more or less minence during the last few years. How- r, of the two particular methods for com- ing plant diseases, namely, spraying and sting, dusting is probably the older of the . It has been stated by some that sulphur s used for this purpose by the Romans bably two thousand years ago, and such scellaneous materials as soot and ashes e apparently used on plants in very early es. Dusting as a regular farm practice y however be considered as having a ginning about the year 1846. From 1857 wards, sulphur dusting was practiced on arge scale in France, and the development this practice was intimately connected h the downy mildew of the grape. For a siderable time after this, dusting was the ndard method of applying such fungicides l insecticides as were applied, although of rse the use of liquid materials was also cticed for various miscellaneous purposes a small scale. The great change in the hod of applying fungicides commenced h the experiments of Professor Millardet the Faculty of Science of Bordeaux, re- ting from his experiments with copper npounds in 1883. The history of the covery of Bordeaux mixture and of its in- ate association with the downy mildew of grape is too well known for any elabora- at this time. It is sufficient to say that fessor Millardet and his associates by eloping Bordeaux mixture were able to trol the downy mildew of the grape, a ease which failed to yield to any other tment. Now, the only practical way of king a good Bordeaux mixture was as a ay, utilizing materials which were avail- e at that time. Professor Millardet and ny others following him were fully alive he fact that dusting had some advantages r spraying, and apparently much work done in endeavors to invent a satis- tory Bordeaux mixture in dust form. This, however, they failed to do and consequently the spray method became the standard method of applying fungicides, and coincidently spray machinery was developed, and to a considerable extent the practice of dusting declined. From that time until about 1912 the practice of spraying extended itself to many different plants and for many different diseases, both insect and fungous. Dusting was however never entirely eliminated and later certain definite advantages of dusting began to be realized, for in the first place it was found that many pests, both insect and fungous, could be controlled without utilizing the Bordeaux mixture, and still later with the commercial development of hydrated lime it became possible to produce a satisfactory Bordeaux mixture in dust form. At the present time then, both practices are extensively followed, and it is fairly well recognized that each practice has a definite place and that each is best suited to certain definite conditions and requirements.

The Present Status of Dusting

In this lecture only brief reference will be made to the present status of dusting. In a joint article with Mr. G. E. Sanders, in the January, 1921, issue of "*Scientific Agriculture*", the following conclusions were stated, with reference to the orchard:

1. Dusting has several definite advantages over spraying.
2. Dusting is as efficient as spraying in the control of scab and of biting insects.
3. Dusting is as cheap, or can be made as cheap as spraying.
4. Dusting is inferior to spray in the control of sucking insects.

Since arriving at those conclusions a great deal more experience has been had and many observations made upon the dust method of pest control, but personally I see no reason to modify the above conclusions with the exception of the last, for at the present time

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the control of sucking insects in orchards by means of the dust method can be very satisfactorily accomplished. The conclusions arrived at as above stated resulted from an analysis of all the experimental data available to that date. Averaging thirty experiments covering four years work in each of the localities of New York, Michigan, Illinois, and Nova Scotia, dusted, sprayed, and untreated plots averaged as follows:

	% Scab	% Insect Injury	% Sound
Dusted	15.6	4.0	74.4
Sprayed	15.6	5.2	71.5
Untreated	56.5	21.4	22.2

It will be seen that in this very comprehensive average the results from spraying and dusting are essentially the same. Since that time the results of experiments have been published from many different sources in the United States and Canada, and we have ourselves also continued comparative tests in this connection. The results have been variable, and due to the different manners in which they are recorded it is rather difficult to establish a comprehensive average stated in figures. However, our own results since the data before mentioned were compiled would give nothing to modify seriously the above results although our dusted plots have not in all cases given quite as good results as the sprayed plots. I notice also in the recorded results of recent years from all the many sources in the United States, that in many cases the dusted plots show equally good pest control as the spray plots, yet there do appear exceptions where the dusted plots fall down to some extent. This phase of the question will be dealt with somewhat later, but it suffices for the present to state that in the main experimental results do not lead one to think that any great modification should be made to the averages struck in 1921.

The results obtained in commercial practice in the orchards are however the real criterion of the success of the method. Surveys of the orchards of the Annapolis Valley, during the last several years, can lead one to no other conclusion than that dusting as practiced by the growers is, in the main, consistently giving results which are very satisfactory. At the present time from one half to two-thirds of the orchards in the Annapolis and adjacent valleys rely upon the dust method for the control of orchard pests and this in itself is fairly satisfactory evidence of the success of the method in orchards for that particular locality. In other orcharding localities on the American Continent the dust method of treatment has spread to a considerable extent and is apparently producing excellent results in the areas to which the method is adapted. But in all this it must be remembered that there are some localities, for example those seriously infested with scale insects, in which dusting may never predominate over spraying.

Dusting the potato is practiced considerably in various portions of the United States though many of the larger potato growing areas are satisfactorily following the spray method. In Canada the dusting of potatoes is followed to some extent. In orcharding districts and where potatoes are also grown an orchard duster is generally utilized to dust the potatoes also. In the potato growing areas of New Brunswick the commercial dusting of potatoes is commencing, and it is thought by several close observers of the situation that the practice of dusting in this locality will increase considerably in the near future. In the proceedings of the Nova Scotia Entomological Society for the years 1918 and 1919 papers appear jointly with Mr. Sanders in which were described the results of dusting potatoes. It was pointed out that excellent results were obtained on small areas from hand dusters, but in those papers were also described the results from four experiments conducted on a large scale in widely separated localities. The average yield of marketable potatoes in these experiments was as follows:

Sprayed—395 bushels per acre
Dusted —376 " " "

The above was of course made when dusting potatoes was in a decidedly experimental stage and little was known about the manner of dusting or the strengths of dust required. In each of the years 1921, 1922 and 1923 experiments have been conducted upon a large scale at the Experimental Farm at Fredericton, on dusting versus spraying o

atoes. The average yield of marketable atoes for the three years was as follows:

Sprayed—363 bushels per acre
Dusted —376 " " "

t must be stated however that the above ires are given with some reserve as in the t of the years in question there was some ible with the dusting apparatus, and in last of the years in question the plots e rogued for mosaic, and the roguing ng possibly uneven the results were taken m a count of the number of hills and not m the area of ground. However, the ve figures are sufficient to show that dust- potatoes, at least under some conditions, be successfully practiced, and results ob- ned commensurate with those from spray-

Dusting has made strides in other direc- s, in fact in all truck crops such as ery, in which Bordeaux mixture spray was merly used, the Bordeaux dust is finding lace.

Dusting is also finding a place in the treat- nt of some of the smuts of grain, if such treatments may be properly termed dust- . Much recent work and much progress been made by treating the seed grain with m two to four ounces per bushel of var- s chemicals. Experiments have clearly wn that results ranging from fair to ex- ent may be obtained from many finely ided copper salts such as the carbonate sulphate, from finely divided nickel and alt salts, and from sulphur. While the trol has not on an average approached standard achieved by the regular liquid tments, yet there is every reason to think t this dust treatment of seed grain will e a definite place in agricultural practice.

No resumé of the present status of dusting uld be complete without mention of the e development of this method of control inst the boll weevil on the cotton plant. far as known at the present time, dusting h calcium arsenate appears to be the only sible method for combating that serious the cotton boll weevil. To the citizens the United States the combating of this t has become a task of the first national portance, and control measures are now ng followed on a tremendous scale. Last year over thirty millions of pounds of calcium arsenate were used on this work alone, a consumption alone practically sufficient to start a new industry in the manufacture of the poison. The scale on which the work is being done may be surmised from the fact that only five or six pounds of the calcium arsenate are used per application per acre.

To sum up the general situation on the status of dusting at the present time, it can be said that in some cases such as the cotton dusting it is proving to be a method of control standing alone and unsurpassed by any other method, and that in other cases dusting is taking or has taken the place of spraying to a very considerable degree depending upon local and economic conditions which will be dealt with a little later.

Dust versus Spray

It is fairly well recognized that each of the above two systems has its advantages. In discussing the pros and cons of this question I will use the apple orchard as an illustration of my point. Time forbids me to deal with each crop in a similar manner, but the reasons which apply to the apple orchard also apply to a more or less extent to other crops, and a person once grasping the main ideas can readily modify them to suit different crops and different localities.

In discussing the present status of dusting I advanced figures representing many averages showing that dusting was equally as efficient as spraying. However, I modified the above statement by saying that in certain instances there had been records where the dusting had fallen down; in our own work we have had such occasional results and I note that recent experiments elsewhere have represented similar conditions. For the last several years we have spent some time each year making a general survey of sprayed and dusted orchards, and as a result of these surveys it can be fairly readily stated under what circumstances dusting fails in its purpose. We have found, with particular reference to apple scab, that where orchards are subjected shall I say to average infestations, dusting will produce a control commensurate with that of spraying. For example, the scab in an orchard which if left alone would result

in say about fifty per cent of the apples being scabbed, should be effectively controlled by the dust method. Under certain conditions and in certain localities, however, infestations develop of an extraordinary character where approximately one hundred per cent of the apples would be scabbed if they were left alone and in exceptional cases where there would even be a very considerable defoliation of the trees. Under these conditions we have noted that dust applied in the regular manner and quantities will not produce as satisfactory control as will spray applied in the regular manner and quantity. It is under these conditions of very bad disease outbreaks that dusting fails to be satisfactory, and it is in localities where such high degrees of infestation are to be looked for where spraying should be maintained as the standard method of pest control. Having stated this one definite advantage which spraying has over dusting we have stated the most important point in favour of the spray method. Spraying of course has some other advantages also. It is the only method which will give a good control of scale insects as far as we are aware although, of course, dormant dusts consisting of sodium polysulphide are made and used and they may eventually turn out to be satisfactory. Also, spraying may lay claim to being superior in the control of sucking insects, although this claim would only hold true to a small degree in the orchard and probably the reverse hold true on potatoes and truck crops. Some have maintained that spraying has a definite advantage in the matter of cost, but under at least many conditions this is not true. The following tables represent approximately the cost of spraying and dusting ten acres of orchard with Bordeaux mixture throughout the season, at prices prevailing in Nova Scotia, and allowing five applications of dust on the dusted area and four applications of spray on the sprayed area:

Cost of Dusting Five Times—Ten Acres

2 men 13½ hrs. each at 25c per hour	$ 6.75
Team 13½ hrs. at 35c per hour	4.72
Interest and depreciation on truck, duster, engine $300.00 @ 20%)	60.00
Gasoline and oil (3½ gallons gas)	1.50
2,500 pounds dust at $4.75	118.75
Total	$191.72

Cost of Spraying Four Times—Ten Acre

2 men 66 hrs. 40 min. each at 25c hour	$ 33.
Team 66 hrs. 40 min. at 35c per hr.	23.
Interest and depreciation ($500.00 @ 20%)	100.
Gasoline and oil (16½ gallons gas)	7.
448 pounds blue stone, 1500 pounds hydrated lime, 108 pounds arsenate of lime	83.
Total	$246.

Of course such costs will necessarily va but the above figures as regards amounts a time used are based on some of our expe mental work, and the matter of depreciati is of course a matter of pure estimate. B it will be seen from the above that five a plications of Bordeaux dust is cheaper apply in Nova Scotia than four applic tions of Bordeaux spray. Of course it is n advisable to use Bordeaux for every applic tion, but the above figures are given to sho comparative prices in a general way. If 9 10 sulphur lead arsenate dust were used i stead of Bordeaux the cost would then slightly more than the spray. The point that there is a prevailing impression amon many that the cost of dusting is greater tha the cost of spraying, and the point I wish make is that in some cases it may be, for e ample spraying costs will vary greatly a cording to water facilities; and in some cas it may not be.

We have then so far stated that the ma advantages of spraying over dusting are:

1. *Better control of pests where pests a present in unusual abundance.*

2. *Better control of scale insects.*

The advantages of dusting over sprayi are somewhat as follows:

1. *Greater Speed in Application.*

The dusting outfit is capable of treati from five to ten times as great an area as spraying outfit in a given time. From th follow several important factors. In th first place it is possible to time applicatio to suit weather conditions to greater adva tage, for the greater speed of dusting mak possible a rapid application of material. I the second place, there is a factor associate

this time saving which is highly import- to a large orchardist. We will assume a man owns a typical one family farm, is, a farm where the work is done by the er with the possible help of a son or two possibly a hired man, with other seasonal k only at picking time. Now this man his pair of horses and a spray outfit and controls the pests in his orchard by the y method. It is impossible for him to any other spray outfits or any other es at that particular time of the year, and finds that the acreage of orchard that he successfully look after is limited by the unt he can spray. If, for example, he twenty acres of orchard he has no sooner hed one application than he must com- ce again, leaving little intermediate time anything else. In this way the number of rels of apples that he can raise on his n is decidedly limited, and it is limited ause the number of acres of orchard ch he can spray is decidedly limited. sider now a man similarly situated who ows the dust method of pest control. He y no means limited in the same way. He double his orchard and still have time dust it and do intermediate work. By owing the dust system therefore this man double or treble his orchard and still trol his insect and fungous pests. In this it is possible for the man to own and cessfully operate a very much larger or- rd when the dust system is followed, than n the spray system is followed. There many men so situated that this factor es above all other considerations and es dusting the method for them to fol- . It would even pay some men, so situat- to follow the dust system even if they did have quite as good a control of pests as hey followed the spray system. To my d it is this factor more than anything else ch is determining whether a man shall or spray, in the Annapolis Valley of va Scotia. The man with the small or- rd can still conveniently spray, for a few rs addition do not mean much to him. the man with a large orchard it is the t thing to impossible to spray. He can neither extra teams nor equipment at the e, and the work must be done and conse- ntly in the growing of clean fruit the t system is his salvation.

It is interesting to speculate on what this factor will mean for the future of orchard- ing. There is a marked tendency for modern orchards to be of larger and ever larger area, which unavoidably means that the dust system will be followed in such orchards, and this to my mind means a definite choosing of or- chard areas where conditions are such that heavy outbreaks of scab are the exception and not the rule. In the planting of trees, this movement from scab-favored localities and towards comparatively scab-free locali- ties, is well on the way at the present time.

2. *Less Waste of Time.*

Spraying has to be done in the best of weather, but dusting is done at night, in the very early morning, or immediately after a rain, during times which are unfit for most agricultural field operations.

3. *Lower Cost of Machinery.*

The cost of a dusting outfit is less than that of a sprayer, and the upkeep is less, and there is less liability to trouble and breakdown in the field.

4. *Lighter Weight of Dusting Apparatus.*

A dusting outfit is not so hard on the horses, and it can go over hills or over wet ground upon which a sprayer could not be used.

5. A duster can be successfully utilized in localities where a nearby supply of water is hard to obtain.

6. Taken collectively growers find dust- ing less troublesome than spraying and the average orchardist will dust more than he will spray because it is less trouble.

To sum up the pros and cons of dust vs. spray it is obvious that sprays should be followed where apple scab is very severe and where scale insects are severe. Under other condi- tions no reason is apparent why the system of dusting should not be of value to the or- chardist, and to the large orchardist, dusting should be of very great value almost ap- proaching a necessity.

Dusts

Having considered in a broad way dusting in general, we will now take up more in de- tail the question of materials which may be used for dusting purposes. It is very obvious

that dusting has to achieve several definite purposes. It may be required to control sucking insects, it may be required to control biting insects or fungous diseases or it may be desired to control any combination of the three mentioned pests. The characteristics of a dust may be much modified by what it is supposed to do. For example, in the control of biting insects alone, say of the type of the potato beetle, the matter of a suitable dust is very simple. It is merely necessary to use any arsenical insecticide, say Paris green, and to use as much diluent such as hydrated lime with it as will insure an even dust distribution. Granted that an even dust distribution is obtained the death of the potato beetles is inevitable and it does not subsequently matter whether the dust is immediately blown or washed from the foliage or not. As long as the dust remains on the foliage for the short length of time necessary to control that particular crop of potato beetles, it does not matter what happens to it afterwards. Suppose, however, that potato blight is a factor also. In this case it is of the greatest importance to have a dust which after being distributed will remain where it is put for the greatest possible length of time.

For the control of the larger leaf-eating insects nothing is more satisfactory than a dust application of some arsenical. The use of diluents, and the particular arsenical to use, vary greatly according to many conditions. For such purposes where dust machinery is available which is capable of making a very light but even distribution of dust, the pure arsenicals may be used. Of these unquestionably the most desirable are, either calcium arsenate, or lead arsenate. Lead arsenate should be used on such foliage as is susceptible to arsenical injury, while calcium arsenate may be used on such foliage as has a certain amount of resistance to arsenical injury. The rates for using these two materials may vary, say from three to ten pounds per acre of calcium arsenate and from five to fifteen pounds per acre of lead arsenate. However, generally when arsenicals are to be applied it is desirable to use a greater bulk per acre in order to get an even distribution and a good adhesion. Speaking generally, where the diluent used is hydrated lime the arsenical preferably should be calcium arsenate, but where other inert diluents are used lead arsenate should be the arsenica These two arsenicals may be used in strengt anywhere from five per cent to twenty-fiv per cent of the bulk dust, and applicatio varying from one-hundred pounds per acre twenty pounds per acre may be used.

While speaking of the use of insecticid alone it is worth mentioning that last season work successfully demonstrated that the a ple maggot may be successfully controlled b the dust method using a ten per cent calciu arsenate dust and applying at the rate o fifty pounds per acre.

A most important phase of work with i secticide dusts, is the comparatively recen development of contact dusts, that is to sa dusts capable of destroying sucking insect It would be impossible at this time to go ex haustively into the successive developmen of contact dusts, but the matter is of suff cient importance to describe in more or les detail the manufacture and characteristics o a contact dust which is very satisfactory.

In producing a nicotine dust the result t be achieved is, first, getting a uniform di tribution of nicotine through a suitable dus carrier, second, having the nicotine in an un combined condition, third, the elimination o all traces of free water, and fourth, it appea desirable that the carrier should be mo or less alkali.

For the most satisfactory production of contact dust a ball mill should be used, a though various dust mixers are reputed to d the work satisfactorily. While on this sub ject it is worth while mentioning that ordin ary types of dust mixers should be used wit great caution in the making of contact dusts It is quite possible to produce a nicotine im pregnated dust which on cursory examina tion is satisfactory, but which on close ex amination is found to have the nicotine i very small isolated globules and not evenl distributed through the dust. In using a ordinary type of dust mixer this unsatisfac tory type of nicotine dust is generally ob tained.

A ball mill is simply a metal or woo cylinder about one-fifth filled with roun iron balls or with smooth round stones. The cylinder should be fitted with a discharg opening shielded by a screen so that the dus

y be discharged and the cylinder still re- n the iron or stone balls.

'o make a contact dust it is necessary to e on hand a supply of finely ground quick e. This is the ordinary burnt lime fresh m the kiln, and it can be readily ground) a dust condition in the ball mill from ch it should be run into air-tight con- ners. The other ingredients to have on d are hydrated lime, and the ordinary mercial nicotine sulphate containing forty cent nicotine. We will assume it is de- d to produce a contact dust containing per cent actual nicotine, or in other rds five per cent of nicotine sulphate. The cedure is as follows for the manufacture one-hundred pounds of such a dust: The is taken off the ball mill, and there is ired into the mill five pounds of nicotine phate. This liquid is just poured over the ls which are in the bottom of the empty. l. To this is then added seventy-five nds of hydrated lime and the ball mill is sed up and is slowly revolved for a period about twenty minutes. At the end of time the ball mill is opened, and there dded twenty pounds of the finely ground ck lime. The mill is then run for another minutes, and then the dust is discharged put into air-tight containers, and it will well to add that the sooner it is used the er the results. The dust thus made ful- the requirements stipulated above. The mill produces an even distribution of otine through the dust, the lime unites h the sulphuric acid leaving the nicotine , and the burnt lime utilizes the free er which originally existed in the nicotine.

'his dust is giving exceedingly satisfac- results on various types of sucking in- s. It is being used considerably in the apolis Valley for the control of green le bug, and apple sucker, and for the trol of potato aphids this type of dust give a better control than can be ob- ed by any other method. It is also effec- against some types of biting insects, as the cucumber beetle.

'arious modifications of this type of dust e been made and it is possible that some the modifications may present points of eriority.

Up to the present time sufficient work has not been done on contact dusts to make possible the utilization of a fungicide along with the contact dust of an assured success. But for my own part I see no reason why a satisfactory formula may not be developed for combining a fungicide with the contact dust, and I believe that this season's work will see the definite establishment of combining fungicides and contact insecticides in dust form.

Dusts used as fungicides are of two types, first, those which utilize sulphur as their active principle and second, those which utilize copper as their active principle. For a few moments we will take into consideration the sulphur dusts.

As was pointed out previously, the use of sulphur dust is very old. Sulphur is an excellent fungicide against certain fungous diseases such as apple scab, but against others such as potato blight it is of very little value. Sulphur to be satisfactory as a dust must be very finely ground and it may be said that its fungicidal value is more or less proportionate to its fineness. Sulphur dust besides being an efficient fungicide possesses very considerable indirect insecticidal properties. Against the bud-moth, codling moth and the green fruit worms sulphur dust will give a considerable measure of control and it is thought that the sulphur in this connection acts more as a repellent than as a direct insecticide. On experimental plots two years ago it was found that the average infestation on three varieties of apples by the above mentioned pests on untreated areas was 23.7 per cent. On areas dusted with sulphur dust the percentage of apples injured was 12.6, the sulphur dust thus giving about one-half of a possible perfect control. The addition of ten per cent lead arsenate to the sulphur reduced the infestation to 5.5 per cent.

With some types of dusters straight sulphur dust does not form a very good dust cloud nor distribute itself as readily as desirable. The addition of five per cent calcined infusorial earth remedies this condition very greatly and produces a good and satisfactory dusting sulphur. However, it is only infrequently that it is desired to use sulphur alone as its insecticidal properties are usually not sufficient to meet requirements.

The sulphur dust generally used therefore contains an admixture of lead arsenate. As a rule, 90 per cent sulphur and 10 per cent lead arsenate produce a very satisfactory combined fungicide and insecticide dust, but if still stronger insecticidal properties are needed the formula of 85 sulphur and 15 lead arsenate may be used. This mixture of sulphur and lead arsenate is the most effective type of combined dust against insects of the orchard.

As a rule, insecticides other than lead arsenate are not satisfactory in combination with sulphur. Calcium arsenate will give a certain amount of foliage injury. Sulphides of arsenic have been satisfactorily used but they have the same fault of sulphur dust, namely, of being dense and hard to distribute. Pure white arsenic has been used with pure sulphur as a dust but this mixture also is heavy and dense and although it may be lightened by suitable additions of infusorial earth yet it is doubtful if this mixture will ever be entirely satisfactory although it may be so, and if so would be a very cheap mixture to use. Dusts containing sulphur as the main ingredient generally have to be used at the rate of about seventy pounds per acre, per application.

To sum up the properties of the sulphur dust, first, it is a satisfactory fungicide against some diseases such as apple scab but of no value against others such as potato blight. Second, the sulphur possesses considerable insecticidal properties. Third, mixed with lead arsenate it is the strongest insecticide of any of the combined fungicides and insecticides against orchard insects.

Of the dusts containing copper there are several different types, and it is noticeable that the copper dusts have a much wider application than the sulphur dusts. The use of sulphur as a fungicide is restricted to certain diseases. The use of copper dusts, on the other hand, is also restricted to certain fungous diseases; but there are apparently a greater number of fungous diseases which will yield to copper treatment more readily than to sulphur treatment.

The dry prepared Bordeaux mixture produced by many manufacturers is of course essentially a copper dust, and has been used both on the apple and on the potato with every success as far as disease control is co cerned. Such dry prepared Bordeaux mi tures are, however, generally expensive a it would hardly be practical to use them c a large scale.

A dust of copper carbonate has also bee satisfactorily used both on the apple and p tato as also has copper sulphide. The fo mer is used to a small degree in practice b is too expensive for general adoption.

Copper arsenite has more recently bee used as the main active ingredient in a co per dust, as also has copper oxide. The latter two have undoubted fungicidal prope ties but whether these will equal standa Bordeaux dust is a matter that by furth work the future alone can tell. While me tioning these copper dusts it may be said th in our opinion it is very probable that t future may disclose the fact that certain d finite copper salts are more toxic to certa definite fungi than others. For example, co per oxide may have but very low fungicid value against apple scab, but it may ha high fungicidal value against the pota blight. We are not yet in a position to sta that these differences do definitely exist, b we have observed many indications whi would point strongly in that direction.

The copper dusts in general use are on which in the presence of water will form Bordaux mixture identical in properties a characteristics with the Bordeaux mixture well known as a spray material. The copp dust most commonly used is one compos of a mixture of dehydrated copper sulpha and hydrated lime. This mixture may made by simply mixing the ingredients t gether, as is the method followed most co monly to date, or it may be made from cr stal copper sulphate and quick lime in whi case the heat of the hydrating quick lime utilized to dehydrate the crystal copper su phate. Almost any arsenical insecticide ma be used with this type of copper dust. Ta ing all things into consideration calciu arsenate is the most satisfactory poison use in the mixture, and calcium arsenate used in practice very largely. There is a ways some demand from some growers f

d arsenate in this particular mixture, and ile this is quite all right and satisfactory it makes the dust somewhat more expen-e.

This type of dust is one which dusts read- forming a good cloud and being com-ratively easy of good distribution.

This type of dust is the one pre-eminently ted to the control of fungous diseases and ing insects on the potato and the general ck and garden crops. As indicated prev-sly its use is spreading rapidly against ato blight and it should be particularly -ful especially in those districts where ght is not very severe. The particular mula to follow for use on potatoes will y according to many circumstances. If orchard duster is being used for making applications, and the applications made heavy, say at the rate of fifty pounds per e then the formula of 12 pounds dehydrat-copper sulphate, 8 pounds arsenate of lime l 80 pounds hydrated lime will be satisfac-y. It is quite possible however to use a re concentrated dust, say 25 pounds de-drated copper sulphate, 15 pounds arsen- of lime and 60 pounds hydrated lime l apply at about 25 pounds per acre. The oblem as to what strength of dust to use the potato is quite involved. Our ex-rience would lead us to believe that in or- to get good distribution and good ad-ion a fairly large amount of dust should utilized, say 40 or 50 pounds per acre. But re is another side to the question, for if grower is buying his dust ready mixed if hydrated lime is not locally available cheap rates, it is obvious that by using a ge bulk of dust he is handling and paying freight on a great deal of inert material. is might make the dust more expensive in tain localities. If the grower is buying dust ready mixed he will probably get active ingredints cheaper in a more con-trated dust. The strength then at which se dusts should be used will probably vary pending upon local requirements and local ces.

This dust is also used extensively in or-rds and with every satisfaction as a rule. the orchards the formula that has been generally followed is, 12 per cent dehydrated copper sulphate, 8 per cent calcium arsenate and 80 per cent hydrated lime, and 50 pounds per application per acre is the rate generally followed. As is apparent from the nature of the dust the active ingredients both fungicidal and insecticidal may be materially increased if it is so desired. In the event of bad insect outbreaks the amount of arsenate of lime could be increased, and in fact doubled without injury to the tree. There are limits however to which the amount of dehydrated copper sulphate may be increased on the apple. Sometimes when amounts of dehydrated copper sulphate such as 20 or 25 per cent are used on the apple there would be noted small purple spots on the leaves; the damage from these is practically insignificant, but there may at the same time be noted similar spots on the fruit, these appearing at their worst about the time the fruit is half grown. The spots later tend to disappear and will probably be barely noticeable at apple picking time though there will be a roughness where the spots have previously shown. Due to this factor it is probably not practical to increase the dehydrated copper sulphate content of this dust beyond say about 18 or 20 per cent.

Bordeaux dust, in a similar manner to Bordeaux spray, produces a russeting of fruit when it is applied in the early stages of the fruit's growth. The amount of this russeting varies very greatly according to the variety of apple and the weather condition. There are times when the russeting is practically not apparent at all and on other occasions the fruit is much disfigured. For these reasons it is very inadvisable to use Bordeaux dust on the apple immediately following the fall of the blossoms. The Bordeaux dust is perfectly satisfactory on pre-blossom applications and is also perfectly satisfactory on the last applications but it is not satisfactory for the calyx application.

Comparison of Bordeaux and Sulphur

The apple grower has frequently to decide whether it would be to his advantage to utilize Bordeaux dust or to utilize the 90 - 10 sulphur lead arsenate dust. A few words on the comparative merits of these two materials would therefore not be out of place.

In the first place, under general Canadian market conditions Bordeaux dust of the formula mentioned as being adapted for orchards can be purchased at about five-sixths of the price of 90 - 10 sulphur lead arsenate dust. In addition to this, in order to get a good dust distribution, about 50 per cent more sulphur lead arsenate dust is required to do the same work as a given quantity of Bordeaux dust. We are therefore faced with a proposition at the start that if we use 90 - 10 sulphur lead arsenate dust our cost for material will be very nearly twice as large as if we used Bordeaux dust. This difference in cost is of course a very important matter, particularly in times such as the present.

Now as to their relative efficiency, it has been mentioned above that both materials have with us produced satisfactory results as far as the control of apple scab is concerned. We note that in experiments elsewhere the sulphur lead arsenate dust has frequently given results superior to the Bordeaux dust, but we ourselves have compared these materials under experimental conditions for five years and I am introducing the following table giving a resume of our findings in this connection. The table covers one experiment in each of the years 1919, 1920, 1921, 1922, and three experiments in the year 1923.

	Bordeaux Dust	90-10 Sulphur Lead Arsenate Dust	Untreated
	% Scab	% Scab	%Scab
1919	20.4	11.4	98.8
1920	24.2	40.0	72.4
1921	4.4	6.4	34.2
1922	10.2	14.8	39.5
1923	6.3	6.7	41.8
	25.0	16.8	71.4
	16.3	23.5	63.6
Average	15.3	17.1	60.2

From the above table it will be seen that the results have been somewhat variable but it will be noted that on the average the Bordeaux dust has given slightly better results than the 90-10 sulphur lead arsenate dust, although the results are very nearly equal. In face of all this evidence, and particularly as it coincides with the results obtained by orchardists, we can only conclude that the Bordeaux dust under Maritime conditions a least, and under the conditions under whic we have carried on our dusting, is at lea equal and probably slightly superior to th 90-10 sulphur lead arsenate dust in the co trol of apple scab.

It is a somewhat different proposition whe we commence to discuss the relative insecti cidal value of the two. It has been state previously that sulphur of itself possesse decided insecticidal value and that combine with lead arsenate the mixture has a ver high insecticidal value. Now, it is unque tionably correct that the Bordeaux dust wi give a quick and effective control of all th leaf-eating insects such as the tent cate pillar or canker worm, but it is equally tru that the Bordeaux mixture gives only a poo control of such partial surface feeders a the green fruit worm, bud-moth and codlin moth. We have also stated that the Bordeau dust is open to the objection of russeting fru immediately after the blossoming period. B it is also at this same period that the greate control of codling moth and green fru worms is to be effected. From the abov data it seems to be possible to arrive at ce tain conclusions, namely, first, if apple sca is the main pest Bordeaux dust is the mo satisfactory to use. Second, if biting insect of the type mentioned above are the mos important pests the 90-10 sulphur lead ar senate dust is the best to use. Third, in th general run of orchards it is quite satisfac tory to use Bordeaux dust on the pre-blosso application, the sulphur lead arsenate on th calyx application, and Bordeaux dust in late applications.

This latter is the procedure followed b most of the dust users in the Annapolis Val ley during the past few years, and to dat we see no reason for making any radical al teration in recommendations for the averag orchard under Maritime conditions.

Dust Adhesion

The relative lack of the adhesion of dust to foliage is, of course, the only real facto which makes them liable to be at any time inferior to spray. Unfortunately no metho has been found yet of radically improving the adhesion of dusts. It is interesting t note the amount of dust retained on leave

varying periods after treatment. For example, on full grown apple leaves it will be nerally found that immediately after treatnt with either dust or spray using standard rmulae, there will be somewhere about om 30 to 50 milligrams of arsenic per ousand leaves. In the case of the spray s amount of arsenic will often be reduced about two-thirds of the original in a week's ne, and to about one-half in about three eks' time. In the case of dust, the original nount of arsenic under the same weather nditions will probably be reduced to about e-half in a week's time and to one-quarter even less in two or three weeks' time. It obvious from the above that dust applicans should be spaced somewhat closer toher than spray applications.

Both Bordeaux dust and sulphur lead arnate dust decrease in a similar manner ore rapidly than spray materials. However, there generally remains a little more sidue on the foliage from the sulphur lead senate dust than from the Bordeaux dust. r example, in one of our experiments, aves from Bordeaux dusted plots contained ly from one to three milligrams of arsenic r one thousand leaves five weeks after the st treatment. The amount of arsenic reaining on the sulphur lead arsenate plot as however 10.8 milligrams. In another se eight weeks after treatment the amount arsenic on one thousand leaves from Boraux treated plots varied from 2 to 3 milliams of arsenic, but from 90-10 sulphur ad arsenate treated plots, one-thousand aves contained from 3 to 4½ milligrams of senic. It is apparent then that there is some all residue remaining on the foliage for a nger time in the case of sulphur lead arnate than of the Bordeaux dust and the int is brought up here as there may be nes and conditions when even such small sidue is useful.

Numerous attempts have been made to inease the adhesion of dusts by the addition various materials. Various oils, greases, axes and materials like dextrin and casein ve all been tried, but as far as our experice goes the extra adhesion has been small. he use of 5 per cent calcium caseinate helps mewhat. Added to sulphur lead arsenate st adhesion was increased so that whereas 3 milligrams of arsenic were on one-thousand leaves of the ordinary dust, 4.6 milligrams of arsenic were on the one thousand leaves of the dust to which the casein had been added, eight weeks after the final application. In a similar manner the adhesion of Bordeaux dust was increased from 2.1 to 2.8. These are however small and we can only conclude that up to the present time we have not become acquainted with any material which may be added to a dust which will give the dust extra powers of adhesion sufficient to make the trouble and expense worth while.

The Mixing of Dust

Many persons who are comparatively small users of dust will doubtless find it to their advantage to purchase their dust already mixed from the manufacturer. But where a person uses a considerable quantity of dust, say an amount over a ton annually, such a person frequently find it advantageous to mix his own dust. Or again farmers' cooperative companies or any group of farmers may find it advantageous to mix their own dust collectively. This home mixing of dust where large enough amounts are used sufficient to warrant it, is not only a cheaper proposition, but the grower has the advantage of a freshly mixed dust which in the case of several dusts is a considerable advantage. When dusts are made in this manner the various raw ingredients are obtained directly from the manufacturer of each commodity, generally from points quite widely divergent. The method of making the contact dust has already been described, so will not be gone into any further. For the ordinary type of dust a mixer is used similar to those in use by the large bakeries for mixing flour. There are many dust mixers on the market being made primarily for various purposes such as cement mixing, and the larger and more specialized types should be used by the larger farmers' cooperative companies. The small type of dust mixer holds anywhere from 100 to 300 pounds of material and the length of time which it has to be mixed is generally about fifteen minutes. The dust should then be run off into cotton bags. A 2½ power gasoline engine is sufficient to run a small type of dust mixer and the total cost of mixing on this small scale should not exceed 25c per 100 lbs. The mixing cost can be reduced

much less than this when mixing is done on a larger scale.

It is almost needless to say that dusts when once mixed should be kept in as dry a place as possible, and in fact in all cases it is preferable to mix the dusts as short a time as possible before using.

The physical properties of the 90-10 sulphur lead arsenate dust deteriorate but little when kept over. This particular dust may satisfactorily be kept over from one year to another in the cotton bags when kept reasonably dry. Bordeaux dust, on the other hand, not only commences to cake if kept from one year to another, but generally about two months after mixing the copper becomes converted to the black copper oxide and loses in value, at least as far as apple scab is concerned. Bordeaux dust should then never be kept over or stored for long periods, at least in cotton. If there is occasion to store Bordeaux dust for long periods this may be done by running it when it is freshly mixed into air-tight metal drums, in which condition it will keep fairly well in its original state.

The mixing of dust cannot of course be successfully accomplished without the workers being considerably exposed to a dust polluted atmosphere. The question of the effect on health of breathing this dust has frequently arisen and for this reason investigations have been made into this phase of the subject. It was found that a person engaged in mixing dusts of the ordinary type would inhale during the course of a ten hour day amounts varying from .01 to .03 grams of As_2O_3. Much of the dust inhaled, however, is retained in the nazal passages and on the nostril hairs and is later expelled, and it was found that approximately one-half of the arsenic was taken into the system. A person engaged in mixing dust may therefore inhale and retain in the system from .005 grams to .015 grams of As_2O_3. These amounts of arsenic are quite large, considerably larger than any of the prescribed medicinal arsenic doses. .13 grams may be taken as representing a fairly accurate dangerous dose of arsenic so that it is apparent that dust mixers may inhale and retain within the system from one-twenty-fifth to a one-eighth of a dangerous dose of arsenic within a working day of ten hours. Arsenic is, however, expelled rapidly from the system, and further, persons taking small amounts of arsenic regularly, develop a very considerable immunity to the toxic effects of this material. Taking all this into consideration there would apear to be little danger from the inhalation of arsenic dust under conditions generally found around the average dust mixer, and experience has shown that no ill effects appear to overtake such workers. However, it must always be remembered that the material is inherently dangerous, and further, there may be cases where persons are more susceptible to arsenical poisoning than usual, so that it is advisable where much dust mixing is done to utilize a dust respirator of some kind.

The poisonous properties of arsenic have been dealt with considerably in works on toxicology, but such work appears to be pretty well confined to the effect of arsenic when taken into the stomach or to the external poisoning. We thought it might be possible that arsenic inhaled as a dust would affect the constitution in some different manner to the arsenic taken in through the digestive canal, so to determine this point work has been conducted utilizing rabbits, and the results clearly show that arsenic inhaled has about the same effect as arsenic taken directly into the digestive canal. This even holds true when care is taken that no arsenic reaches the stomach directly. In the case of rabbits in which the oesophagus had been securely tied and the rabbits subjected to arsenical dust, arsenic was found in large quantity in the lungs, and also arsenic could be detected within a very short time after treatment in all the organs of the body. The effect of inhaling arsenic is to all intents and purposes the same as taking arsenic directly into the stomach, and so as we mentioned previously it is advisable to utilize a dust respirator when engaged in the mixing of arsenical dust.

Dusting Machines

A dusting machine consists of a fan or blower, a dust container or hopper, and the feeding mechanism. The arrangement of this combination of course varies in machines of different makes but the aim of all is to have a hopper that will hold as much dust as can be conveniently carried, a feeder that will regulate the dust discharge at any desired

antity, and a fan that will produce a blast air sufficient to carry the dust to the re-ired parts.

The smallest type of dusting machine is one at is carried and worked by the operator, mely, the hand duster. The operation of is type of duster is generally quite labor-us and it is really only adapted to quite all areas. These hand dusters have a very ort life and we have not been entirely sat-ied with any of the types which have come our notice.

The next type of duster is one which is ounted on two wheels, with the driving wer for the machinery furnished by these eels. The better types of these machines e very satisfactory for the potato and for ck crops.

The next type of duster, larger than the ove mentioned, is the power duster which nsists of a four-wheel waggon with a dust-g machine and gasoline engine mounted on e platform. This latter is of course the pe adapted to orchards, and it is also a pe which may be very satisfactorily adapt-to potatoes or other truck crops.

For operating the duster in the orchard, st one dust outlet, generally known as a ve-pipe outlet, is utilized, and this gives e best dust cloud for even distribution over es. For operation on the potato and such ner kindred crops, a boom attachment is ed to the rear of the machine, and the air st is split up into several streams which ows of the dusting of several rows of p.

An interesting type of dust distributer has en developed, which is particularly adapted the control of aphids or other sucking in-cts on potatoes and such crops, and al-ough primarily adapted for sucking in-t control yet at the same time it gives as od a dust distribution to all parts of the nt as any other type of dust distributer. the rear of the duster the dust stream is lit up into a number of streams, the num-r depending on the power and the capabil- of the duster and the number of rows of p it is desired to dust at one time. The st distributing tubes are arranged on a om which by manipulation of a lever will lower the dust distributors among the crop or raise the distributors over the crop when making turns. There are two dust outlet pipes for each row to be dusted and these outlet pipes are carried on small shoes which drag on the ground in the centre between the crop rows. From this shoe each dust outlet pipe extends just a few inches and is pointing towards the crop row with a slight upward tilt. Attached to the boom at the rear of the duster is a large canvas sheet which drags over the top of all the rows to be dusted and which extends in the rear for about fifteen feet or so. By means of this apparatus the dust is driven against the under side of the foliage of the crop being treated, and the dust is held in a violent whirling motion under the canvas and thoroughly permeates all parts of the crop.

By the use of the apparatus just described it is possible to obtain a 99 per cent control of potato aphids using as a dust the contact dust previously described, and applying it at about the rate of 75 pounds per acre. This control is of course effected very rapidly and the control is moreover more nearly perfect than may be secured by any other method. It is generally considered that the sucking insects of potatoes have much to do with the degeneration type of potato disease such as mosaic, and this method of sucking insect control may play a great part in the control of such types of potato diseases. Experiments to determine these points are under way by the combined efforts of officers of the Entomological Branch and Botanical Division.

Dusting Methods

It has been shown previously that the adhesion of a dust to foliage is not as great as the adhesion of spray. Dust is more liable to be washed off by rains than is the sprayed material. It therefore follows that, as a rule, dust aplications should be spaced closer together than spray applications, to accomplish the same work. It follows further that set rules cannot be as readily made for the period at which dusting should be done, as can be made for spray methods. For example, with the orchard a person may draw up a definite spray schedule adapted to the needs of a particular locality. One may

spray shortly after the leaves have started growth, again just before blossoming, again just after blossoming, and again a fortnight later, and be assured that such a program will give results. However, with dusting such a set program might fall down, for one or more of the applications may be taken off the foliage prematurely or an application may be made inadvertantly which does not set well on the foliage. In these cases further applications have to be made, so that following a dust program it is much preferable to keep a sharp watch on the foliage through the infection period and to apply fresh dust when the material from the previous dusting has more or less disappeared. The periods between dusting may sometimes be of short duration and sometimes have a fairly long duration. As a rule it is our opinion that about five dust applications should be reckoned on to achieve the same purpose as four spray applications.

The particular times when dusting should be done are highly important. The ideal condition for dusting is when the air is perfectly calm and when the foliage is moist from a dew or a recent rain. Such times, of course, cannot always be found and the dust user must pick out a period as near to the ideal conditions as possible. As a rule the air is calmer between the hours of sunset and sunrise, and moreover between these hours the air is more humid and there is liability to be a dew. We used to consider that the best time for applying dust applications was from the commencement of daylight until about 7 or 8 a.m., but during recent years I have noted some of the best dusting results from night applications. Both periods are however satisfactory. Work may commence when the wind goes down in the evening, and if it is a moonlight night, dusting may continue all through the night if necessary. Or even when there is no moonlight but a fairly clear sky, I have seen excellent applications made to orchards by persons skilled in dusting. When a good night is struck with the air still and humid and a dew forming towards morning, I have seen dust applications made on occasions every bit as thorough and with just as strong powers of adhesion, as spray materials would have been. The importance of choosing the proper time for dusting cannot be over-emphasized. Under poor conditions one might just as well throw the dust away, but the proper conditions have to be looked for and the available opportunity seized.

Some workers on the dust method have recommended that for orchards dusting should be done from both sides of the tree, but it is worth mentioning that all of our experimental data and all of our work have been based on dusting from one side of the tree only.

Many have thought the operation of dusting requires less skill than the operation of spraying but in our opinion as far as work in the orchard goes, this is not so. Anyone who has seen an amateur worker engaged in dusting, and then observes the methods followed by an old hand at the game, will appreciate the difference. Skill is required in determining when to dust, and furthermore, the handling of the dust outlet is no job for a careless or inexperienced man. A steady but fairly slow walking team is required and the dust outlet has to be pointed in a slow easy circling motion towards each successive tree in a manner so that all parts of the tree from one end to the other are enclosed in an evenly distributed dust cloud.

There are two types of dusting, namely, first, the dust cloud system, and second, the dust drive system. Most of the dusting done depends upon the dust cloud system, and in getting dust adhesion from the slow settlement of a dust cloud which completely surrounds the tree. This is the only type of dusting which it is possible to do with a low powered duster. The dust drive system is where the dust can be driven with such force through all parts of the foliage, that the adhesion is secured by the actual forceful driving and hitting by the dust particles against the plant parts. This latter type of dusting invariably gives much better dust adhesion, and it would be very interesting to see if the future will bring forth a super-duster which will render capable the following of the dust drive system in the orchard.

Future Dusting Developments

It is not easy to forecast the future of dusting. It will have a definite place in agricultural operations but as pointed out previous-

y it will by no means supersede the operation of spraying. It has taken and will continue to take the place of spraying in certain instances, in other instances it will act as an auxillary to spraying. In a few cases it will establish methods of pest control which were not previously possible, but on the other hand in some localities, spraying will remain the standard method of insecticide application. The above particular instances have been more or less indicated during the course of this paper.

The dusting machine may, however, be capable of developments as yet only barely foreseen. The term "dusting" generally used means the application to plants of dust particles by means of a blast of air. It is quite feasible that this blast of air might also be utilized for projecting on to the plants materials other than dust particles. Considerable work has been done on the utilization of vapors and gases by means of a dusting machine. In some cases more or less satisfactory results have been obtained by projecting such vapors and gases as nicotine vapor, tetrachloroethane vapor and hydrocyanic acid gas. It is our opinion that there is a lot of promise in such methods, and so far the main stumbling block against such methods is the technical work involved in the making of suitable apparatus auxillary to the duster, which will do the work right. It is entirely possible that the future may see the projection of vapors and gases by means of a dusting machine the regular part of that particular branch of farming operations.

There has recently also been developed a method of applying liquid materials by means of pressure obtained by the aid of a pump upon the liquid itself. But the new type of machine utilizes an ordinary dusting machine and projects the liquid on to the plant by means of the air blast. Now, it is quite feasible that by the elaboration of this method the actual operation of spraying may be made with something approaching the same speed as the operation of dusting, that is to say, with the exception of keeping the tank filled with water. This system may prove a very valuable addition to both spraying and dusting methods. For example, the Bordeaux mixture might be applied by throwing out a finely divided mist of a fairly concentrated copper sulphate solution and at the same time dusting with hydrated lime dust. Also, nicotine might be applied in a fairly concentrated form as a light mist projected from a duster, while at the same time the regular dusts are being projected in dust form coincidently. All these things show very decided promise and the modifications mentioned above are ones which are actually being done by us this season, and the results from which will be apparent within a short time. It is also obvious that such a dusting machine capable of projecting liquid may be utilized when weather conditions are such as to make for poor dusting, while the dust machine may be utilized for dust alone under good dusting conditions.

The Trend of Agricultural Prices in Canada.*

H. MICHELL

Department of Political Economy, McMaster University.

In considering this subject, I have decided to confine myself to two lines of thought, the first being the consideration of the relation of prices of agricultural commodities to manufactured goods, and secondly, the relation of prices of grains to meat products. Both these topics present aspects of considerable interest, and no small importance, and I think we shall be able to arrive at some conclusions that will perhaps be illuminating.

To deal with the first inquiry, the relation of prices of foodstuffs to manufactured goods, allow me first to state some rather obvious truisms. We are told that man doth not live by bread alone. Quite true, but it is equally true that man cannot live without bread. Men, if they are not dyspeptics, are hungry three times a day. Children, I speak with the experience of a father, seem to be hungry at least twelve times a day. Man must eat to live and his food must be provided for him. Nature is bountiful, and except under singular conditions of famine in certain restricted areas, there is always enough food at least to keep body and soul together in everyone, and what is more, and here I approach the first cardinal point of my argument, the world must produce enough foodstuffs if the human race is to continue, and at a price which will enable the people to buy enough to keep them from dying of starvation.

It is at this point that we encounter a paradox, so it seems to me, in that for an absolute necessity which people must buy, the price cannot for any length of time, indeed for a very short time only, rise above what can be paid by the poorer classes of society. The price of foodstuffs may rise temporarily to a great height; we saw as much in the great war; it was seen in the struggle with Napoleon, but they inevitably sink back again. It is impossible, I assert, to raise permanently the price of agricultural products above a level that may be said to represent the ratio between total income and food requirements. If you press me as to what that ratio exactly is, I fear I would find difficulty in giving you a satisfactory answer. To calculate such a ratio would be well nigh impossible for all classes. As income increases the ratio between expenditure on food and expenditure on housing, clothing and luxuries drops. As income decreases the ratio rises, and as we come to such peoples as we find in the East, vast masses in India and China for instance, we find that an overwhelming proportion of the income of the individual goes toward the provision of food. I am using the term income here, of course, in a very loose sense.

But while, as I have said, the prices of agricultural products can never rise above what we may suppose roughly to be the level of purchasing power, and indeterminate level admittedly of the world's population, the same is not true of all other commodities. Man must have food, and in our colder climates he must have clothes and fuel and shelter to keep him alive, yet he can and will economize in even these latter necessities and will certainly economize very vigorously in what we may call luxuries. To reiterate once more my fundamental proposition, he cannot for any length of time go hungry, but he can and will do without other things. He will go shabby where he would, if he had the money, go well dressed. He will deny himself all kinds of luxuries; even to-day he will go without a motor car or drive a shabby one instead of a new and shiny one. And so we come to what I venture to call my second fundamental proposition which I have already suggested, namely that as prosperity wanes the ratio of food products to manufactured goods rises, and as prosperity increases this ratio falls. This proposition is, I think, capable of fairly exact demonstration. I have taken the index numbers of prices in England compiled by that very eminent statistician, Mr. Sauerbeck, and now

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ontinued in the financial journal, "The Sta-ist." I am forced to take English prices be-ause I cannot get any series of index num-ers over a sufficient length of time outside of ngland. The Sauerbeck number is con-eniently divided into various classes, food-tuffs, raw materials, manufactured goods, tc., and I would ask your attention to the ollowing series of ratios between the indexes f food and materials. In order not to make he list too long, I have taken the ratios at he beginning of each decennial period com-nencing at 1850 and by years from 1846-49. must confess that this method is open to rave technical objections, the principal one eing that Sauerbeck chose his base year at 867, both indexes of food and materials tanding at 100 at that year. This would give he impression, of course, that in that year he ratio is exactly 1:1, as according to this omputation it is, while if we took another ear as one base, the ratio would be quite dif-erent. But with that word of caution I will ow present to you the series.

Ratio of Foodstuffs to Materials (Sauerbeck)

1846	1	:	0.93
1947	1	:	0.90
1848	1	:	0.92
1849	1	:	0.95
1850	1	:	1.02
1860	1	:	1.02
1870	1	:	1.06
1880	1	:	0.89
1890	1	:	0.97
1900	1	:	1.16
1910	1	:	1.09
1920	1	:	1.12
1923	1	:	1.05

Permit me just to mention that another nethod by which we would calculate the de-iation of both series from the mean would ive even more illuminating results. I will ot, however, go into that point now as it ould involve me in rather a complicated xplanation of the mathematical formula ecessary for such a calculation, but will tick to my ordinary arithmetic ratios. Al-ow me to ask your very careful attention to hese ratios, which are, I venture to say, of xtraordinary interest and on examination ighly illuminating.

In the first place, please notice the low atio of materials to foodstuffs prior to 1850. I am sorry I cannot take the figures back be-yond 1846, the first year of the Sauerbeck index. It could be done, with a little ex-penditure of trouble, by calculating from the other index compiled by Jevons and now con-tinued in the Economist, but I have not done so. The low ratio of materials to foodstuffs is simply nothing more than a statistical demonstration of the truth of the saying "the hungry forties." Times were bad, peo-ple were not buying more than they were obliged to, consequently the larger propor-tion of the income went on the prime necessi-ties of life—food. But things improved, the great railway building era came, wealth in-creased, gold flowed into Europe from Cali-fornia and Australia, and we see the ratio changing steadily, the expenditure on manu-factured articles showing a higher ratio than the prices of foodstuffs. But again notice the changing ratio in 1880 and 1890. After 1878 prices definitely turned downwards reaching their lowest point in 1896. The gold from California had all been absorbed and the South African and Klondike gold had to come, times were bad, and down goes the ratio of manufactured goods to food-stuffs. Again by 1900 the corner has been turned. The Rand mines are pouring gold into the world and the great leap in prices which lasted for 23 years, culminating de-finitely and unmistakably in 1920, carried the ratio of manufactured articles to food-stuffs up again. And now will you notice that it is declining once more. In 1923 it has fallen from 1:1.12 to 1:1.05.

There is no possible doubt whatever, all competent observers are unanimous, that we are definitely in the downgrade in prices. I could very easily demonstrate to you from the precedents of the years following the great struggle with Napoleon and the Civil war in the United States that a prolonged decline in prices is simply inevitable, and with that decline in prices goes with it equally inevitably, a decline in prosperity. I beg you not to think me unduly pessimistic nor a preacher of blue ruin, but I cannot doubt, no careful student of economic affairs can doubt, that we are slowly slipping from our former times of prosperity. To some the transition will be painful, to others, and I firmly believe the vast majority of men and women of stout hearts, the change will come

as a tonic. No one who has observed the era of extravagance and luxury through which we have come can doubt for an instant that a good deal more hard work and plain living will do us all good.

But to return to the problem of the ratios once more. If I am right, and I venture to think I am, the present disproportion between what the farmer buys and what he sells will pass away, is even pasing away now. What has been troubling the farmer as everyone knows, is not that he has been receiving low prices for his wares, but that he has been forced to buy what he wants at a disproportionately high rate to what he has to sell. Prices of agricultural products in Canada are to-day on a carefully calculated weighted average about 21 per cent in advance of the prices of 1913. That is quite satisfactory so far as it goes, but it is not at all satisfactory when we find that at the very best showing what the farmer buys has advanced anywhere from 50 to 80 per cent in the last eleven years; the ratios are all out of proportion and the farmer has suffered and is suffering now. These disproportions and maladjustments will surely right themselves. As I said when I began, the world must have food and food at a price at which it can buy. Does this mean a progressive rise in the values of foodstuffs? No, by no means, but it does mean a rectification of the ratios between what the farmer sells and buys. That seeming paradox of which I spoke, that the hungrier the world gets the lower go the prices of foods will undoubtedly function once more. You will notice that the ratio of materials and foodstuffs falls to its lowest in the two periods of hard times, the forties and the eighties and nineties. I do not think that the farmer is going to improve his economic position through a rise in the prices of foodstuffs, but I do most assuredly think that his economic position is going to be a good deal sounder that it is to-day. Economic insecurity is always occasioned by inequality, by a dislocation of relative proportions; economic security is always grounded on a stable and equitable ratio between the wealth of all classes.

Ratio of Prices of Meats to Grains

To turn now to the second inquiry to which I would invite your attention, the ratio of prices of grains to meat and animal products. I have here these ratios taken from the index numbers of the Department of Labour at Ottawa, for grains and meats in Canada from 1890.

RATIOS OF GRAINS TO MEAT AND ANIMAL PRODUCTS—CANADA 1890-1924

Year	Grains		Animals
1890	1	:	0.94
1895	1	:	0.92
1900	1	:	1.06
1905	1	:	1.04
1910	1	:	1.16
1914	1	:	0.97
1917	1	:	0.98
1920	1	:	1.22
1922	1	:	1.31
1924 (April)	1	:	1.25

This series also presents points of peculiar interest. Observe please the low ratios for 1890 and 1895; the rise after 1900; the fall in 1914 and 1917 and the great rise in 1920 and 1922. Perhaps it is a little too much to say absolutely that the ratio is falling, at least from the evidence of April 1924. Such an assertion would be very dangerous to make simply on such grounds, but as I will explain in a moment there is every reason to suppose that such is the case. I submit to your consideration the suggestion that in this series of fluctuating ratios we have a most significant fact. Meat is, after all, a luxury. To great masses of the world's population, meat is an unattainable luxury. But mankind likes meat and will eat it whenever it has the money, just as it will eat sugar in as large quantities as possible, the world's consumption of sugar fluctuating exactly with the price of the refined product. Meat will be bought when there is sufficient money to buy it, or when the prices fall to the level where large numbers of people can buy it. For instance, a most interesting thing is the fact that the introduction of cheap frozen New Zealand mutton into England uncovered a potential class of meat eaters who up to that time had eaten very little meat, and who eagerly took the opportunity of buying the new meat at so low a price. But setting that aside, people will buy meat when they can and will not buy it when their incomes are too low to permit of luxuries. But they will always buy bread; they must in order

to live. Therefore, at periods of depression when luxuries are curtailed, the ratio of meat to grain falls. Observe please the first decade 1890 to 1899, with the low ratio, which turns upwards quite noticeably in 1900. As a matter of fact the turn came in 1897 when prices began to rise definitely, although I am very chary of using isolated years like that. I think it allowable to take years at the beginning of each decennial period because whatever peculiar accidents may pertain to any single year yet an unmistakable trend is exhibited. You will of course observe how the ratio tends to rise up to 1910 and has fallen steeply again in 1914 when the serious depression immediately preceding and following the outbreak of war was upon us. It is of course very unsafe to speak of the war period and I am not at all sure I ought to have included 1917, however, there it is. But by 1920 we are very distinctly on the up turn, the climax being reached in 1922 and now we are very decidedly in the down turn, although as I have cautiously observed we must not judge untimely by the falling ratio. What will probably be the course of the ratios in the future? I have very little doubt indeed that the ratio of meat prices to grain will steadily drop. When man is hungry and has very little money to buy food, he buys bread, when he has a little more money he buys meat. If we worked out the ratios between foodstuffs, and say such a luxury article as furs we would find precisely the same tendencies in an even exaggerated form.

I would very much like to go into the whole subject of the rise in meat values, it is an inquiry of quite exceptional interest, but it would take one far too long to deal with it adequately, indeed it is a whole investigation in itself. Perhaps, however, I may just mention a few points that will be suggestive to you. Writing 150 years ago, Adam Smith in his wonderfully acute treatment of the problem of the rent of land remarked: "In almost every part of Great Britain, a pound of the best butchers meat is, in the present times, generally worth more than two pounds of the best wheat bread; and in plentiful years it is sometimes worth three or four pounds." I observe with interest that the price of a pound of ribroast beef in Toronto is exactly four times the price of a pound of bread. But if we compare the prices of a somewhat more expensive cut, sirloin steak, we find a suggestive thing. In 1890 a pound of sirloin steak was just 3½ times the price of a pound of bread. In 1924 the price is well over five times. What is the meaning of this? Undoubtedly the reason may be found in two considerations; first, a liking for the better cuts and an increased ability to pay for them, and second, the rapidly rising price of meat products occasioned by the pressure of population on the productive capacity of the world to furnish meat to the people. According to the census of agriculture in the United States, the peak of swine production was reached in 1880 at 0.95 per capita, in 1920 it was 0.56. Sheep stood at 0.81 in 1900, in 1920 at 0.33. Beef cattle reached 0.66 in 1900, in 1920 it was 0.42. The output per unit of the population is steadily dropping and the prices rising; the era of cheap meat is over.

Only a moment ago I said that I was confident that the ratio of wheat to meat would undoubtedly drop. Now I say that the era of cheap meat is definitely over. The explanation of this apparent paradox I apprehend to be as follows. As population presses more and more hardly upon the means of subsistence and as the inexorable law of diminishing returns functions with ever increasing insistence, the possibilities of meat production will be gradually curtailed. The peoples of the world will eat grains because they cannot afford to eat meat, just as in India and China and Japan to-day vast masses are grain eaters because they cannot afford to eat meat. The ratio of meat prices to grain prices will fall, but the price of meat, a luxury for the comparatively few will remain at a high level. Meat as a diet is a most wasteful luxury. An ox eats as much as five men and requires three times as much land for his support. The ox that consumes as much as five men lives at least two years, and produces perhaps 750 pounds of meat. If we reckon that an average ration of meat is one-quarter pounds a day, a low estimate since the regular army ration is 20 ounces a day, we arrive at the conclusion that the ox provides 3000 days' ration, while the amount that he has eaten would represent 3750 days' subsistence for the cereal eater, which simply means that 750 days' rations

are lost to the world for every ox raised for the market.

But I cannot follow up this line of inquiry any further, a fascinating one in itself but must remark that to-day as never before the fundamental truth of the law of Malthus is becoming clear, that population tends to increase quicker than the means of subsistence. And now to conclude by way of summary. The conclusions that I present are briefly as follows: I submit, first, that the present dislocation of price ratios between what the farmer buys and what he sells will inevitably re-adjust itself. While you can never raise the price of basic foodstuffs, such as wheat for any time above what mankind can pay, at the same time you cannot depress that price for any period below the cost of production. There is an equilibrium of prices of foodstuffs which oscillates, sometimes very little, at other times somewhat violently, about that figure which is just sufficient to allow the peoples to buy and also to keep sufficient growers in the market to supply the world's needs. Economists who have a most terrifying jargon of their own call that the point of marginal utility, but we need not trouble ourselves what the economists call it. Past experience shows us that a violent disturbance of ratios between manufactured goods and foodstuffs always rights itself in time, and as a matter of fact it is righting itself now. From that we can take comfort, although perhaps it may be somewhat cold comfort for the starving horse to be told that the grass is undoubtedly about to grow.

Second, I submit that the disturbance in the ratio of grains to animal foods will also right itself, although at the same time, I do not believe for a moment that we are going to see cheap meat again.

And lastly, I must strongly hold that these movements, these readjustments work themselves out inevitably and that we can do very little, perhaps nothing at all to affect them. The Romans were pretty wise old people and I expect that you remember their old proverb about nature not making any jumps. The contemplation of such violet mental observations as the happily defeated McNary Haugen bill is a saddening one for the economist. If it isn't greenbacks then it is free silver and now it is this or that which will serve agriculture. But the pea is always under the other thimble, not the one you are sure of. Nature works out her own salvation and incidentally or rather inevitably the salvation of the farmer at the same time.

NEW VEGETATION AND FOREST COVER MAP.

The Natural Resources Intelligence Service of the Department of the Interior, partly as a result of the great number of enquiries received, has prepared and published an exceedingly interesting Vegetation and Forest Cover Map of Canada. This map shows at a glance the different zones of vegetation and their chief distinguishing characteristics, from what are known as the barren lands, that are in no sense barren but support a growth of hardy grass and vegetation peculiar to the cold climate, to what is termed the Carolinian zone, in southwestern Ontario, where is found almost sub-tropical vegetation in the fruit belt.

The enormous area of Canada must of necessity provide a wide range of vegetation and forest conditions. In the northern country, extending from the shore of Hudson Bay to the Mackenzie delta, the white spruce struggles for existence, while on the southeastern portion of Vancouver Island are found a number of Californian types of trees, the most remarkable being the Madrona, or arbutus, the only broad-leaved evergreen tree in Canada.

An immense amount of hitherto unpublished information is shown on the new map, much research work was entailed, and the notes of explorers and surveyors, from those of Sir Alexander MacKenzie, Sir John Franklin, Samuel Hearn and others to the more modern surveys and explorations of the different Federal and Provincial government departments, were carefully examined for authentic records. To the student of Canadian conditions the new map will be of much assistance in enabling him to segregate the several vegetation zones, approximate the possibilities of forest exploitation, and establish the areas of known farming districts.

The Chemistry of Some Butter Defects.*

A. L. GIBSON

Professor of Dairy Chemistry, Ontario Agricultural College, Guelph.

The commercial value of butter is naturally based upon quality, and quality is very largely determined by flavor. Any defect in flavor means a considerable reduction in the market price of butter. For instance, in March, 1924, a leading English grocery firm possessing a large chain of stores advertised two qualities of butter in the *Manchester Guardian* as follows:

Special Prize Danish Butter 1s. 11d. per lb.

First Prize Colonial Butter, 1s. 7d. per lb.

This means a difference of eight cents per lb. between the price of Danish butter as compared with the price of butter from some portion of the British Empire.

The reason for the high price of Danish butter on the British market is undoubtedly due to its superior flavor. We, in Ontario, envy the Danes their butter trade with Great Britain, especially at the present time when all dairy produce is being produced greatly in excess of home production. It is pleasing to note and gives hope for the future, that whilst Ontario butter in general is not looked upon favorably elsewhere, some Ontario dairymen during the past year have demonstrated their ability to produce the highest quality butter by obtaining First Prize against world competition.

Since flavor is the main determining factor of the quality and commercial value of butter it is the purpose of this paper to draw attention to the chemistry and causes resulting in some defective butter flavors. Butter flavors are classified with such words as *stale, flat, bitter, oily, metallic, rancid, yeasty, fishy* and *tallowy*. Owing to the reduction in value which accompanies such flavors considerable investigation has been made to determine their causes and prevent their development. Generally speaking such investigation has not met with a high degree of success for several reasons, among which may be mentioned:—

1st. The same flavor being identified differently by various investigators.

2nd. A lack of reliable and recognized chemical methods for the isolation and measurement of the small amount of substance capable of producing a particular flavor.

3rd. The need of co-operation between the chemist, bacteriologist, and experienced butter judge.

In the time allotted for this paper it is impossible to discuss completely the chemistry underlying all flavors occurring in inferior butter and, therefore, attention will be paid to two extreme but very serious and costly defects in butter, namely, *Tallowy* and *Fishy Flavors*. The causes and prevention of these butter defects will be seen to be almost identical with other inferior flavors of a finer but equally important character.

Tallowy Flavor

Before considering the cause of any particular butter flavor we might briefly review the chemical composition of butter itself. The composition of butter may be stated to consist of

Water	11.	to 15.5%
Fat	87.	to 80.
Casein	.75	to 1.5
Salt	.75	to 2.5
Ash	.50	to .5
	100.0	100.0

Butter fat contains triglycerides of the following acids:

Butyric	—C_3H_7COOH—5.45%
Caproic	—$C_5H_{11}COOH$—2.09%
Caprylic	—$C_7H_{15}COOH$—0.49%
Capric	—$C_9H_{19}COOH$—0.32%
Lauric	—$C_{11}H_{23}COOH$—2.57%
Myristic	—$C_{13}H_{27}COOH$—9.89%
Palmitic	—$C_{15}H_{31}COOH$—38.61%
Stearic	—$C_{17}H_{35}COOH$— 1.83%
Oleic	—$C_{17}H_{35}COOH$—32.50%
Dihydrostearic	—$C_{17}H_{33}(OH)_2COOH$—1.00%

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The first four acids are volatile and soluble or slightly soluble in water, whilst the remainder are non-volatile and insoluble. The triglycerides of butter fat probably do not exist as glycerides of one fatty acid but with several acids, as for example glycerylbutyro-oleo-stearate. One of these acids may be replaced with phosphoric acid united to choline, a tertiary amine and alcohol combination CH_2 OH. $CH_2N(CH_3)_3$. OH forming a curiously complex compound with glycerol and stearic acid known as lecithin $C_{44}H_{90}NPO_9$. The amount of lecithin present in butter is estimated at from .0433% to .0723% being highest in unripened cream butter and lowest in well ripened cream butter. Traces of cholesterol $C_{22}H_{43}OH$ replace a little of the glycerol in butter fat and a natural coloring matter consisting of carotin and xanthophyll is also present.

The casein present in butter contains at least fifteen aminoacids. Most of the ash content is associated with the casein but our knowledge of milk ash as it actually exists associated with other milk constituents is anything but complete.

From this brief statement regarding the composition of butter we realize the complexity of its chemical nature and its susceptibility to chemical change.

Characteristics of Tallowy Butter.—Tallowy butter has a distinct taste and odor of spoiled tallow with a pale bleached color, or entirely white, which may in time change to pinkish brown. Tallowiness renders butter quite unfit for the market. The pure fat has a lard-white color and is almost colorless when melted. If the volatile acids and odors be distilled off with steam the residue is more intensely tallowy, showing a distinction between rancidity and tallowiness. Rancidity is caused through certain species of bacteria and molds which bring about a process of hydrolysis forming free volatile fatty acids. Tallowiness appears to be entirely the result of a chemical change brought about mainly through an oxidation process. The tallowy butter-fat, though of lighter color than the original butter-fat, gives a dark yellow soap upon saponification, whilst the original butter-fat gives a clear straw-colored soap. Tallowy flavor is sometimes stated to be due to an aldehyde and this dark saponification product may be due to reaction of the aldehyde with alkali. The pink color which develops in old tallowy butter is due to an action on the curd since we find that it is insoluble in the fat but readily extracted by water and absorbed by the curd. Tallowy butter-fat is more crystalline and has a higher melting point than that of normal butter.

Tallowiness very seldom develops in cold storage butter, but rather in butter exposed to ordinary room temperature. It develops from the exterior inwards and is more common in print than in box or tub butter. Under such conditions a period of three to six weeks is usually necessary for the defect to become pronounced.

Causes and Chemistry Underlying Tallowy Flavor—The earliest investigations conclusively proved that butter and pure butter-fat will turn tallowy if the cream, during the process of manufacture, or the finished product is unduly exposed to the atmosphere. High temperature and sunlight are also conducive to the defect. These simple agents naturally point to a process of oxidation, and it has long been thought that tallowiness was due to the oxidation of the unsaturated fat olein. Whilst it is true that the olein is to some extent oxidized in tallowy butter and the Iodine Absorption Number reduced, though this reduction is very slight, later investigation shows this to be quite an inadequate explanation of tallowiness. Olein is not easily oxidized and experiments with renovated butter show that butter oil may be blown at a pasteurizing temperature without impairing the flavor, grain, or keeping quality of the finished product which would be impossible if tallowiness were strictly due to oxidation of the fat. Tallowy butter is produced in commerce where exposure to air and heat is carefully guarded against. It would thus appear that there are other causes than simple oxidation for the development of tallowy butter. Recent investigation goes to show that the partial oxidation of olein is merely coincident with the development of tallowiness since oxidized oleic acid when added to butter to the extent of reducing the iodine number from 87 to 79 does not show a tallowy taste or odor. This suggests that the true cause of tallowy butter is due to

products formed in the butter during the absorption of oxygen by the oleic acid such as glycollic acid ester of oleic acid, the glycollic acid coming from the oxidation of glycerol. These possible by-products are not formed during the oxidation of pure olein, which together with previous statements regarding the difficulty of oxidizing olein would lead to the suspicion of other oxidizing agents being present in butter which becomes tallowy. Hunziker has conclusively shown that oxidizing agents or catalizers are provided by metals such as copper, brass, German silver, iron, together with the oxides and salts produced from these metals. The acidity which naturally develops in milk and cream readily dissolves these metals should they come in mutual contact as in the case of worn and badly tinned shipping cans and pasteurizers. Tin and nickel do not seem to assist in the production of tallowy butter.

Though acidity greatly encourages the presence of the metals in cream and butter, it is curious to note that tallowiness does not develop in the presence of acidity. If, however, a slight excess of alkali accompanies the presence of copper, tallowiness is rapidly produced. Lactose and casein are also accessory to the reaction, especially the former, in fact lactose in a slightly alkaline media at room temperature but without metals has been known to turn a sample of butter tallowy in two days. Though casein assists in the reaction it will not produce tallowiness without a favorable metal. In the absence of casein the pink or brown color seen in old samples of tallowy butter does not develop. This suggests a partial hydrolysis of the casein liberating its amino acids, which on oxidation, especially in the case of tryptophane, yield colored compounds. During the past five years the practice of adding alkali to destroy the high acidity of cream received in many of our creameries before pasteurization, has become very common. It will be realized that unless this complication in the practice of dairying is carried out with every care and skill, ideal conditions may be brought about for the production of tallowy butter.

Though it has been stated that the production of glycollic acid is more likely to be the actual cause of tallowy butter than the simple oxidation of olein, yet there is an element of uncertainty regarding this since when free glycollic acid is added to butter-fat tallowiness is not produced. Moreover, a study of the saponification, iodine, and Reichert Meissl numbers, together with the melting point, acid value, refractive index and other butter-fat constants of good and tallowy butter-fat does not reveal a sufficient variation to account for the oxidation of olein or formation of glycollic acid in any appreciable quantity. Nevertheless, investigation shows that the glycollic acid ester of the fatty acids in butter, especially olic acid, when warmed with butter-fat does produce a tallowy flavor, and we find glycollic acid naturally in the fat of sheep's wool showing its close relationship to tallowy odor. Again, glycollic acid is one of the chief products formed by the action of copper hydrate in alkaline solution on lactose, or of copper acetate on glucose, levulose or galactose. Probably the amount of glycollic ester necessary to produce tallowiness is so small that present methods for obtaining the butter-fat constants fail to show any marked difference from the pure butter-fat.

Summary of Chemistry Related to Tallowy Butter—Briefly we may state that tallowy butter is probably due to a process of oxidation whereby not only olein is oxidized, but also glycerol which is produced by slight hydrolysis of the fat. The product formed from the glycerol is glycollic acid. The oxidation is dependent upon the following:

(a) Exposure of cream and butter to air and especially in conjunction with high temperature and light, favors oxidation.

(b) Lactose in a natural or slightly alkaline media greatly assists the reaction.

(c) If butter is made under good conditions from fresh cream ripened to a reasonable acidity tallowiness does not develop through the presence of lactose, in fact properly controlled lactic acidity may act as a mild preservative.

(d) Copper and its alloys such as brass and German silver, together with the salts formed therefrom, and which gain access to butter through over-acid cream, act as oxidation catylizers. Iron and its compounds will also assist this oxidation in

a similar manner, but their action is not so pronounced.

(e) An unnatural alkaline condition of cream and butter increases the oxidizing action.

(f) Casein, together with copper and its salts, but not alone, facilitates the production of tallowiness and is responsible for the pink or brownish color present in the later stages of development.

Fishy Flavor

Fishy flavor is essentially a storage defect and occurs in cold storage and export butter. Fresh butter of the highest score may become fishy during storage. Colonial butter from Australia, New Zealand and South Africa has suffered tremendous losses on the British market from this defect. In Australia, fishy flavor is designated as "Australia's costly taint" since it is estimated that it causes a loss in export butter averaging over $500,000 annually. Nearly all butter which considerably deteriorates in storage shows signs of fishiness.

Causes and Chemistry Underlying Fishy Flavor—Volumes could be written regarding the various opinions submitted since 1890 by numerous investigators and writers making a study of fishiness in butter. From the mass of data on hand at least twenty different factors are advanced in explanation of the development of fishiness. After a perusal of the many reasons given for this defect in butter one is convinced, however, that it is befittingly named of the many stories told.

There are two main theories for the cause of fishiness, namely, that it is brought about through biological agencies and, scondly, that it is the result of purely chemical reaction. The biological agencies mentioned as being concerned are yeasts, molds, bacteria and bacterial enzymes. The following three objections seem to discountenance largely the biological theory:—

1st. Inoculation experiments with the organisms supposed to cause fishiness have in general been unsuccessful.

2nd. Pasteurization does not absolutely prevent fishiness.

3rd. Fishiness is favored by a high salt content and develops at low temperatures, conditions which are inhibitory to micro-organic life.

Recently Sommer and Smit of the Agricultural Experiment Station, University of Wisconsin, have conducted a very comprehensive piece of research respecting fishy flavor in butter which supports the chemical theory and clears away the ideas which have favored biological activity.

Opinion seems to be fairly unanimous that the substance which causes fishy flavor in butter is trimethylamine, the mother substance of which is lecithin. By partial hydrolysis lecithin yields choline which on oxidation forms trimethylamine. Trimethylamine does not occur in fresh butter, but it has been found to be present in fishy butter to the extent of twenty-three to thirty-six parts per million. The small amount of trimethylamine which is capable of producing fishiness in butter and the difficulty in isolating and separating such amounts no doubt accounts for the variety of opinions concerning the cause of fishy flavor. The optimum conditions for the production of trimethylamine from emulsions are the same as those for the development of fishiness in storage butter. The conditions which are found to favor the development of fishiness in butter are:

1. High acidity of cream.
2. High salt content in butter.
3. Over-working of the butter.
4. The presence of iron and copper salts.

Acidity encourages fishiness because acids favor the hydrolysis of lecithin and oxidation processes in butter, besides bringing iron and copper into solution from cream containing vessels.

Salt favors the development of fishiness because it intensifies flavors in general and increases the solvency of lecithin necessary for chemical action. The incorporation of salt requires additional working of butter.

Overworking incorporates air more thoroughly in butter and may increase the air content. Iron and copper assist by acting as catalysts in the oxidation of choline.

Undoubtedly butter made from pasteurized cream is not so susceptible to fishiness as butter made from unpasteurized cream, a

fact which lends support to the biological theory. It is now found, however, that pasteurization causes the lecithin to absorb oxygen and become less soluble. Pasteurization also causes partial hydrolysis of the lecithin, forming products which are soluble in buttermilk. Thus, butter made from pasteurized cream may be so reduced in its soluble lecithin content that sufficient trimethylamine cannot be formed to produce a fishy flavor.

Conclusion—Prevention is the only remedy for tallowy, fishy, or any other defect which may develop in butter. The chemist may become involved in the most intricate and interesting lines of research work establishing the cause of any defect in butter or other milk product, but inevitably he will discover that some fundamental principle of good dairying has been broken. What are the remedies for the prevention of tallowy and fishy flavor of butter, established from the vast amount of work carried out in the laboratories of the numerous agricultural colleges and experiment stations? They are simply these:

1. Use pure sweet cream for the manufacture of butter. Having obtained such a raw product at the creamery the butter-maker has a reasonable chance to control acidity and any other natural development which milk and cream inevitably undergo.

2. Avoid complicating the process of manufacture by the use of chemicals or other foreign substances such as "neutralizers," etc. There is no need for such when handling sweet cream.

3. Pasteurize the cream and if it is desired to develop a certain degree of acidity, do so through the aid of pure culture provided through the skill of the bacteriologist.

4. Do not allow cream to come in contact with poorly tinned or copper utensils.

5. Avoid excessive salting.

6. Avoid overworking.

7. Practise the art of cleanliness in the highest degree. Are not these remedies the simple rules for good butter manufacture which have been established for generations past? No doubt the practical man will say that these rules are ideals that can no longer be followed with profit commercially. And yet our commercial rival, the Dane, is shrewd enough to fulfil these ideals in every-day practice. What is possible in Denmark is also possible for the farmer and dairyman in Ontario, but so long as we attempt to make butter from a raw product in which undesirable and uncontrolled chemical action has started, so long shall we be denied a creditable status on the export market.

The Inter-Relation of Growth and Fruitfulness in Plants.*

E. J. KRAUS

University of Wisconsin, Madison, Wis.

It is a common expression of the fruit grower, gardener, and even the investigator, to say that the plants in which he may be interested are not producing fruit because they are too vigorous, or, on the contrary, because they are not sufficiently vigorous. From this one would imagine there must be some especially favorable middle point, at which plants were at just the right stage of vegetativeness to favor fruit production, as if in some way the latter were a true product of the former. In fact, at times it has been implied that excess vigor in itself was destructive of fruitfulness, and that any factor which would tend to suppress such excess vegetativeness would at the same time tend to promote fruitfulness. On the exact contrary, it has also been suggested that plants should be in a thrifty condition to be fruitful, and when this is not the case fertilizers, cultivation, and the like should be employed to make them so. Contradictory as these statements may seem, they point to the well recognized fact that there is an inter-relation between vegetativeness and fruitfulness. If there has been a fault, it lies in a failure to recognize that although these functions are associated, yet each is the expression of a condition of nutrition prevailing within the plant, and that it is through a change of this condition that these functions can be modified. Mere increase or decrease of vegetativeness as such do not mean increased fruitfulness, unless such increase or decrease is the result of a changed plane of nutrition, a plane of nutrition at which fruit production takes place along with a certain degree of vegetativeness. This naturally brings up a question, however, concerning the possible extent or nature of growth which would be made by a plant provided the blossoms or developing fruits were removed completely or in part, in varying stages of development. What, in other words, would be the fate of materials being supplied to both developing fruits and branches, provided the fruits are removed? What would be the extent and character of the vegetative extension produced under such conditions? What, if any, is the inter-dependence of vegetative extension and the production of fruits?

More than thirty-five years ago it was shown that when grain plants were making very little growth and producing very little grain in soil deficient in nitrogen, if increments of nitrogenous salts were applied, that with the first of these both the amount of straw and of grain produced increased greatly. With successive increases in the amount of nitrogen applied, there was an increase in the proportion of grain to straw. With still further additions of nitrogen, however, the production of straw was still greater, but the proportion of grain decreased markedly. Experiments comparable to these have been repeated many times with similar results. They not only furnish a clear cut, concrete example of the principles previously stated, but give a suggestion that fruitfulness is not necessarily a product of vegetativeness, but that each is a method of expression of a nutritional condition, that differences in proportions of material income and material transformation are reflected in what the plant is.

In the case of tree fruits examples of this same general sort are not lacking. How frequently one has heard the fruit grower lament the fact that his trees are not sufficiently "thrifty" to bear, or on the contrary express his wonderment as to why his large, vigorous trees are not producing a crop of fruit. In the former case he is frequently advised to add nitrogen in some form, or other mineral fertilizers to his soil. Often the results are most encouraging—greater vegetativeness and fruitfulness of the trees

* Paper presented at the Fourth Annual Convention of the C.S.T.A., June, 1924.

being secured. In the second instance, in former times he was frequently advised to prune "judiciously"—especially during the summer time—in order to suppress this vegetativeness. Again the results were satisfactory, in so far as checking growth was concerned, but the presumed increase in fruitfulness failed to materialize. This result frequently seemed confusing, all the more so when it was observed that if such vegetative trees were checked by certain other means, such as lessened pruning, decreased cultivation or withholding applications of manures or other nitrogen-containing fertilizers, then abundant production of fruit buds frequently took place. Evidently then it was not the mere suppression of vegetativeness in itself which induced fruitfulness, but rather a possible association of the two conditions under some circumstances, and not under others. The question naturally asked itself therefore, if this suppression in vegetation might not be of at least two different types, brought about by different causes. And with the additional fact, that fruitfulness might be decidedly increased along with an increase in vegetativeness, the second question arose, where is the point in the range of the various degrees of vegetativeness at which fruiting is at a maximum? It is with this question that a number of horticulturists have been engaged for several years past. Such problems as the following are being worked upon. What is the length, diameter, and character of the wood and bark of spurs, most likely to be associated with fruit bud formation and with fruit setting? What is the same condition for terminal growths? Where are the spurs most likely to mature fruits located, with reference to age of wood and part of tree on which they are borne? From this some interesting correlations have certainly been reached, but at best these correlations are but refinements of broader observations, and must be subjected to much greater refinement still before they will give a material basis for suggestions on which to base practice. Positive results from such studies have been gained. They will help to give the fruit grower a fairly ready and fairly accurate measure of gauging the condition of his trees. Most of these problems, however, will surely find their final reference to studies in nutrition, and while a final solution will be long in coming, it can hardly be said that some suggestive progress has not been made.

If it is permissible to assume that there is an interrelation between vegetativeness and fruitfulness, that both may be associated in varying degrees of intensity of expression, and that vegetativeness is often manifested unassociated with fruitfulness, then one is interested in determining the nutrient relations associated with these several conditions. In attempting a study of this it is not difficult to study, in a general way, the situation as it may prevail in plants which are vegetative only. But if the plant is both vegetative and fruitful at the same time, it becomes desirable to know how much of the material income of the plant is going into fruits and how much into vegetative structures other than fruits. One question which arises is, to what extent do the developing fruits tend to suppress vegetative extension?

It is a well recognized fact that during a year of heavy fruit production, fruit trees generally tend to make less length growth than they do during years of light fruit crops though this is not invariably true. So marked is this, that discussions concerning the tendency of alternate bearing, frequently are the most vital ones at gatherings of fruit growers. While the general effects of a heavy crop of fruit on the growth of a tree are well known, it does not seem true that scarcely enough attention is paid to the fact. When one stops to think of the amount of carbohydrates, acids, salts, and the like, which go into the make up of a good-sized fruit crop, and remembers that these are usually completely withdrawn from any further use to the tree as a whole, the importance of considering the influence of a crop on vegetative behavior takes on new proportions. The same amount of materials represented in leaves, stems, limb and trunk diameter, root extension, and food storage would in itself bulk large, and if even a part of this material had gone into the formation of leaves during the growing season the total amount of stored material might well be even greater. While records of crop produced are generally kept in association with pruning, tillage, and other orchard experiments, the significance of such records in relation to plant behavior seems often to be at least partially overlooked. Particularly is

it important to take into account the presence of flowers and fruits when calculating growth rates and making growth curves. Unfortunately this frequently has not been done.

One of my associates, Mr. A. E. Murneek, has recently been devoting much attention to the influence of developing fruits upon the vegetativeness of tomato and some other types of plants. Briefly stated, he has found that with a low nitrogen supply to the plant, the presence of one single, small fruit absolutely inhibits the continued extension of the vegetative tip, and precludes the formation of additional blossoms, but if such a fruit is removed growth is quickly resumed, (even though no additional nitrogen is given), blossom buds are developed and another fruit may start to develop with the consequent complete stoppage of further extension of the growing point. With higher proportions of nitrogen in the soil three or four fruits are required to bring about such suppression, and with additional quantities of nitrogen even more are necessary. Stated in another way, when relatively large quantities of nitrogen are present, the plants are vegetative and fruitful at one and the same time—the material income of the plant goes to form both fruits and strictly vegetative parts, vegetativeness decreasing as the number of fruits increases. When nitrogen is decidedly restricted, the condition of suppressed vegetation is complete with the presence of but a single small fruit. If plants are grown with a relatively large supply of nitrogen, and the fruits are removed as soon as they begin development, vegetativeness proceeds uniformly. Thus if two plants are grown side by side under identical nutrient conditions, and the fruits are removed from one and allowed to remain on another, the former continues growing rapidly, the latter, unless the quantity of nitrogen is exceedingly high, elongates more and more slowly as the fruits accumulate and grow in size.

These experiments are suggestive and highly important from many points of view; they have been but briefly mentioned here to indicate the necessity of taking into consideration the influence of fruits on growth, as well as studying and making measurements of vegetative parts in attempts to get some measure of the capacity of trees for fruit production. The intimate correlation existing between the two conditions is strikingly emphasized. It should be remembered, however, that the production of a crop of seeds by perennial plants is not always by any means the devitalizing or exhausting process it is frequently thought or said to be.

Instances of the wide variations which may exist in the inter-relation of vegetativeness and fruitfulness may be found in the relatively recent experiments of Garner and Allard which deal with the influence of light on growth and flower production. It will be recalled that they found at least three classes of plants; those markedly inhibited in growth but flowering at a relatively advanced time when exposed to a shortened daylight period, but became markedly vegetative if this period were prolonged; those which behaved in quite the opposite manner; those which appeared to respond almost quantitatively to the period of light exposure in that as the light exposure period was increased vegetativeness and finally blooming and fruitfulness also increased. Buckwheat is an example of the first class, radish of the second, and tomato of the third. It should be pointed out that in those cases in which blooming is hastened under short periods of light exposure the plants are decidedly dwarfed in stature, and the number of blossoms or fruits few. The plants have in this respect at least, a superficial resemblance to those plants which are scarcely vegetative and but moderately fruitful because of a deficiency of nitrogen, except that the former are more green. A detailed study of the two types of plants would show them to be quite different in composition; physiologically they are far from being identical, whatever the associated conditions of growth and fruitfulness may seem to indicate. This is but another example showing the necessity of a nutritional study, beyond a record of generalized resemblance.

Since Garner and Allard generally used soils abundant in mineral nutrients, those plants which grew and bloomed with a relatively long day, and were dwarfed by the shorter exposure, perhaps properly may be considered comparable with the usual type of plant grown under the conditions of soil treatment and light exposure generally prevailing in most experimental work carried on

uring the long days of summer. The responses of the third class of plants find their ounterpart in the recorded results of many xperiments, in which light conditions were ot specifically considered. A discussion of ese results in relation to conditions of nuition is taken up elsewhere.

There are plenty of records purporting o show that growth is an autocatalytic reacon, that it is governed by more or less inngible growth promoting, or growth inibiting substances. Certainly not all these re without point. All such records are aluable, but too frequently specific data and vidence do not take into consideration the hole body of facts presented within the exeriment or those which could be drawn om other sources and related with it. To ttempt an explanation based on physical easurements alone, even though these include vegetative, flowering, or fruiting parts, is unsafe. Correlations may be thus determined, but these may be related back to very different underlying causes even though superficially resemblances are close. It is extremely dangerous therefore to make recommendations for cultural practices on the basis of such observations and measurements alone. Let us have these observations; but so long as growth and fruitfulness remain material things, we must know the material exchanges and interchanges associated with these varied expressions on the part of plants. Knowing these, it is necessary to find out how these may be influenced; whether the same result may not be produced in several ways. When facts are really known, it is not difficult to free them from cumbersome terminology and studies in nutrition become the most helpful guides in rationalizing horticultural practices.

Present Day Problems in Crop Production.

SIR E. JOHN RUSSELL, F.R.S.

President of the Agricultural Section, British Association for the Advancement of Science.

(Concluded from September issue)

All these problems will sooner or later nd some solution. But there remains a reater problem of more importance than ny of them: the linking-up of plant nutrition udies with those of the soil solution. As ur cousins in the United States were the rst to emphasise, the fundamental agent in e nutrition of the plant is the soil solution, nd they have made a remarkable series of vestigations into what appeared at one me a hopeless proposition — the physicoemical interactions between the soil and the il water. Whitney and Cameron began the ork, and it has gone on with much conoversy—as important scientific investigaons always do—and it is now being atcked with much vigour by some of the ounger scientific workers, particularly in e Californian school: Burd, Hoagland, Kelly, Lipman, Stewart, Sharp, and others. here is also some valuable work by Gola nd other Italians. The natural soil solution is not always the best for the growth of plants. It is reasonable to suppose that the most efficient method of using fertilisers would be for making up the soil solution to the optimum composition and concentration for each stage of the growth of the crop. Unfortunately, this cannot yet be done. The added fertiliser does not simply increase the concentration of the soil solution to the precise extent that might be expected; there are interactions, absorptions, and base exchanges of the kind studied first by Way, much later by van Bemmelen and by Gedroiz, and more recently by Hissink and Wiegner. Further, the plant relationships are not constant; there is apparently—though this is not certain—more response to certain nutrients at one time of its life than at another. A great advance in crop production may be expected when the soil chemists have discovered the laws governing the soil solution, when the plant physiologists can give definite

expression to the plant's response to nutrients, and when someone is able to put these together and show how to alter the soil solution so that it may produce the maximum effect on the plant at the particular time. The new soil chemistry will yet have its triumphs.

The Soil Micro-organisms: Can they be Controlled ?

It is now more than forty years since the discovery of the great importance of micro-organisms in determining soil fertility. Practical applications necessarily lag far behind: but already three have been made, each of which opens out great possibilities for the future. The long-standing problem of inoculation of leguminous crops with their appropriate organisms has already been solved in one or two of its simple cases, chiefly lucerne on new land, and the new process has helped in the remarkable extension of the lucerne crop in the United States and in Denmark. We believe at Rothamsted that the more difficult English problem is now solved also. Interesting possibilities are opened up by the observation that a preliminary crop of Bokhara clover seems to facilitate the growth of the lucerne.

The organisms effecting decomposition are now coming under control, and are being made to convert straw into farmyard manure (or a material very much like it) without the use of a single farm animal. The process was worked out at Rothamsted, and is being developed by the Adco Sydicate, who are now operating it on a large scale and are already successfully converting some thousands of tons of straw annually into good manure.

The third direction in which control of the soil organisms is being attempted is by partial sterilisation. This process is much used in the glasshouse industry in England and it has led to considerable increases in crop yields. The older method was to use heat as the partial sterilising agent, and this still remains the most effective, but owing to its costliness efforts have been made to replace it by chemicals. Considerable success has been attained; we have now found a number of substances which seem promising. Some of these are by-products of coal industries; others, such as chlor- and nitro-derivatives of benzene or cresol, are producible as crude intermediates in the dye industry.

The Need for Fuller Co-operation

Looking back over the list of problems it will be seen that they are all too complex to be completely solved by any single worker. Problems of crop production need the co-operation of agriculturists, plant physiologists, soil investigators, and statisticians. Even plant breeding necessitates the help of a physiologist who can specify just what the breeder should aim at producing. And this gives the key-note to the period of agricultural science on which we have now entered—it is becoming more and more a period of co-operation between men viewing the problem from different points of view. Good individual work will of course always continue to be done, but the future will undoubtedly see a great expansion of team work such as has already led to important results in medical research, and such as we know from our experience at Rothamsted is capable of giving admirable results in agricultural science.

The team work should not be confined to individuals working at the same institution. The world would gain greatly if co-operation such as now exists between the Imperial College Botany School and Rothamsted could be effected between other great institutions devoted to agricultural science in the various countries of the world. To take only one illustration: how much could be accomplished in the study of the very difficult alkali problem if it were possible to organise a team representing such great agricultural stations as, for instance, California and Utah, the Departments of Agriculture of India and other of the great Dominions affected, Rothamsted, Hissink's school, with power to lay down experiments anywhere and money to carry them out? And if extended co-operation of this kind should prove impossible of attainment, much could be done by fostering co-operation between the Agricultural Institutions of the Empire. There are certain great problems which are common to large parts of the Empire where the experience of one part would be of great value to the rest. The institutions in Britain, for example, have experience of problems connected with land long since set-

d and brought into cultivation, where men ıst produce 40 or more bushels per acre wheat and 6 to 10 tons per acre of potatoes make these crops pay, and where animal sbandry must be run on sound and econ- ıic lines. Canada has an unrivalled ex- rience with wheat, and in the Western ovinces has a magnificent chance for study- g one of the most important problems of e day—the water supply to the crop. Aus- ılia, New Zealand, South Africa, East, West, d Tropical Africa, India, the West Indies to mention only a few in the great family at forms the British Empire—all have their ecial lines in agricultural development; ch has some achievement that can be shown th pride and in the certainty that its study ll benefit others. The Empire has already Conference of Premiers; why should it t have its conference for agricultural ience and practice?

With fuller co-operation both of men and institutions we could do much to overcome e present difficulty in regard to utilising the formation we already possess. In the last irty years an immense stock of knowledge s been obtained as to soils and crops— owledge that ought to be of supreme value interpreting the facts of Nature as shown the field. It is stored in great numbers of lumes which line the shelves of our lib- ries, and there much of it rests undisturbed dignified oblivion. In the main it consists single threads followed out more or less refully; only rarely does some more gifted orker show something of the great pattern ıich the threads compose. But even the ost gifted can see but little of the design; e best hope of seeing more is to induce ople to work in groups of two or three, ch trained in a different school and there- re looking at the problem from a differ- t point; each seeing something hidden from e rest. Unlike art, science lends itself to is kind of team work; art is purely an in- vidual interpretation of Nature while ience aims at a faithful description of Na- re, all humanistic interpretation being minated. There is certainly sufficient good ll among the leaders of agricultural science justify the hope of co-operation; there are obably in existence foundations which uld furnish the financial aid.

And that leads to my last point. What is e purpose of it all? Team work, co- eration, the great expenditure of time and money now being incurred in agricultural science and experiment—these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. That view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties — which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigators that tie themselves down to purely practical problems do not get very far; all experience proves that the safest way of making advances, even for purely practical purposes, is to leave the investigator unfettered. Our declared aim at Rothamsted is 'to discover the principles underlying the great facts of agriculture and to put the knowledge thus gained into a form in which it can be used by teachers, experts, and farmers for the upraising of country life and the improvement of the standard of farming.'

This wider purpose gives the investigator full latitude, and it justifies an investigation whether the results will be immediately useful or not—so long as they are trustworthy. For the upraising of country life necessitates a higher standard of education for the countryman; and education based on the wonderful book of Nature which lies open for all to read if they but could. How many farmers know anything about the remarkable structure of the soil they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses; of the wonderful wheel of life in which the plant takes up simple substances and in some mysterious way fashions them into foods for men and animals and packs them with energy drawn out of the sunlight—energy which enables us to move and work, to drive engines, motor-cars, and all the other complex agencies of modern civilisation? No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem dull by comparison and would dispel for ever the illusion that the country is a dull place to live in. Agricultural science must be judged not only by its material achievements, but also by its success in revealing to the countryman something of the wonder and the mystery of the great open spaces in which he dwells.

Concerning the C.S.T.A.

Two of the outstanding agricultural authorities with the British Association for the Advancement of Science, the Right Honorable Lord Bledisloe, K.B.E., chairman of the Lawes Agricultural Trust, Rothamsted, and Chairman of Agricultural Research, University of Bristol; and Sir Edward John Russell, Director of the Rothamsted Experimental Station, were guests at a luncheon given in their honor at the Legislative Buildings, Regina, by the Southern Saskatchewan Branch of the Canadian Society of Technical Agriculturists. Addresses were given by Lord Bledisloe and Sir John Russell, and a vote of thanks to the speakers moved by Hon. C. M. Hamilton, Saskatchewan Minister of Agriculture and seconded by W. J. Rutherford, Dean of the College of Agriculture, University of Saskatchewan.

Under the auspices of the Eastern Ontario Branch of the Society, Dr. R. F. Ruttan, Dean of the Faculty of Graduate Studies, McGill University, and Dr. F. C. Harrison, Principal of Macdonald College, recently addressed a meeting of members of the Society on the question of arranging a course of graduate studies at Ottawa. There are many members of the C.S.T.A. in Ottawa, chiefly in Government service, who find it impossible to attend a course of graduate studies at a distant College, but who are anxious to take up the work. Mr. L. H. Newman, President of the Eastern Ontario Branch, outlined this condition of affairs in a letter to McGill University, and the meeting held on August 21 was the outcome. Both Dr. Ruttan and Dr. Harrison expressed the view that something could be done to meet the needs of the situation, and further developments are expected within the near future.

The Southern Saskatchewan branch of the Canadian Society of Technical Agriculturists held their annual picnic at C. M. Learmounth's cottage, Regina Beach, July 12. The Club was well represented, and a very enjoyable time was spent. The committee in charge of refreshments were—Mrs. Dr. McClellan, Mrs. W. W. Thomson, and Mrs. J. G. Robertson. The sports committee were—F. H. Auld and W. W. Thomson.

NOTES

The following members of the Society are taking postgraduate work at the University of Wisconsin:

G. H. Cutler (O.A.C. '09) Professor of Field Husbandry at the University of Alberta.

P. H. Ferguson, (O.A.C. '20), formerly District Representative at Maple Creek, Sask.

S. J. Hetherington, (Macdonald '21) Markets Specialist in the Saskatchewan Department of Agriculture.

Andrew Fulton, (O.A.C. '21), Assistant Director of the Fruit Branch, Ontario Department of Agriculture, has been appointed Assistant to the Dominion Fruit Commissioner.

J. E. McOuat (Macdonald '15) has been appointed Principal of the Intermediate School at Kenogami, P.Q. He has held the position of Lecturer in Nature Study at Macdonald College for the past five years. His removal from that institution has made it necessary to appoint a new secretary to the Macdonald College Agricultural Alumni Association, which position Mr. McOuat has occupied since 1919. The new secretary is Mr. T. C. Vanterpool (Macdonald '23), Assistant in Botany at Macdonald College.

J. F. Hockey (Macdonald '21) has been transferred from the Dominion Laboratory of Plant Pathology at Fredericton, N.B., to the new laboratory at Kentville, N.S., as Pathologist-in-charge.

Fred H. Grindley (Macdonald '11), General Secretary of the C.S.T.A. returned to Ottawa on September 22nd, after a vacation of two months in Great Britain. While overseas, he visited the Rothamsted Experiment Station, the British Ministry of Agriculture, the University of Edinburgh and the West of Scotland Agricultural College at Glasgow.

eport of the Committee on Educational Policies.*

L. S. KLINCK, Chairman.

President, University of British Columbia, Vancouver.

INTRODUCTION

'our Committee beg to present the fol-ing report;

ubsequent to the Macdonald Convention, r Committee worked steadily on the task btaining, compiling and interpreting data ting to educational policies. These data e been collected through correspondence through personal interviews which your irman had with members of the Commit- and also with a large number of other resentative Canadians who are keenly in-sted in agricultural education.

t the Saskatoon Convention, the results he year's work were submitted not as a nal Report, but rather as a summary of vailing tendencies. After consideration discussion, the Convention instructed the mmittee to continue their studies. Further, Executive was authorized to appoint two committees, one to deal with Agricultural cation in Public and High Schools, the er to deal with Agricultural Schools. The orts of these Committees will be presented he following order:

. Report of the Sub-Committee on Agri-ural Education Policies in Public and h Schools.

Members: Mr. J. W. Gibson, Chairman; Mr. F. W. Bates, Dr. J. B. Dandeno, Mr. L. A. DeWolfe.)

. Report of the Sub-Committee on Edu-onal Policies in Agricultural Schools.

Members: L. S. Klinck, Chairman; H. A. Craig, A. T. Charron, W. J. Bell.)

II. Report of the Committee on Educa-al Policies in Agricultural Colleges.

Members: L. S. Klinck, Chairman; E. A. owes, J. B. Reynolds, H. S. Arkell, M. Cumming, Father Leopold, F. C. Harrison, W. J. Rutherford, C. H. Lee.)

PART I.

PUBLIC AND HIGH SCHOOLS

A. Public Schools.

1. Status of Agriculture on the Curriculum.

Agriculture has a place in the curriculum of studies for public or elementary schools in all of the provinces of Canada. In all cases it is introduced in combination with, or as a part of Nature Study and is so treated throughout the first four of five grades. The economic and scientific aspects of the subject are usually introduced in the 5th and 6th grades and emphasized in the 7th and 8th. In four of the provinces Agriculture is reported as a compulsory subject in the higher grades, whilst in the other five it is assigned but not made compulsory. In one of the provinces Elementary Agriculture and Horticulture forms an alternative or optional course with Nature Study in the last four grades of the Public School.

Conclusions

It is the opinion of the committee that Agriculture, on account of its national importance, intrinsic value and educational interest should be regarded as a regular and therefore compulsory subject of study in the upper grades of the public or elementary school, following and growing out of Nature Study in the preceding grades.

2. Character and Scope of the Work.

The amount and character of the work assigned in Elementary Agriculture in the different provinces is extremely variable. Some assignments are so meagre as to suggest lack of appreciation of the importance of the subject, whilst others are so comprehensive as to suggest overloading of the curriculum.

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* Presented at the Fourth Annual Convention, C.S.T.A., June, 1924.

All of the provinces report a measure of activity in what might be termed the operative or achievement aspects of the work such as school and home gardening or other home projects of an agricultural character. Three of the provinces reported school gardening as having been the most popular of the three above-mentioned forms of practical agricultural work; three others gave home gardening as having attained the greatest popularity and the remaining three gave the preference to agricultural home projects. In most of the provinces some attention had been given to all three lines of work. Several of the reports would indicate that the home project method of agricultural study is gaining ground.

Conclusions

The all too prevalent practice of making Agriculture a book subject cannot be too strongly condemned. Some form of practical work should be required such as school gardening in the lower and intermediate grades, followed by home gardening or other home projects in the upper grades.

3. Organization and Support.

In five of the provinces Agricultural Education is under the direction of a special officer or director. Four of these directors are under Departments of Education and one is under the Provincial Department of Agriculture. Whilst the present tendency is to place all Agricultural Education work under Departments of Education, there still remain a few cases where officials of Provincial Departments of Agriculture have general direction of the work.

In the matter of special financial assistance only three of the nine provinces make special grants to School Boards towards the cost of the practical end of the work—School and Home Gardening and Agricultural Home Projects. In the same three provinces teachers who conduct the practical work in accordance with the regulations receive bonus grants direct from the Department. The amount of the bonus varies with the technical agricultural qualifications of the teacher. These bonuses run as high as $50.00 a year in one province and as low as $10.00 a year in another. In one of the provinces School Inspectors receive a special bonus for promoting or inspecting the school garden work. The discontinuance of Federal support may result in a complete withdrawal of bonus grants to teachers, and possibly to school boards as well.

Conclusions

All Agricultural Education work, which relates definitely to the Course of Study should be under the Department of Education. Wherever feasible and when so agreed upon co-operation of Faculties of Agriculture and Departments of Agriculture should be encouraged. Special effort resulting in more efficient work in school agriculture on the part of the teacher should be recognized by bonus grants or in some other way, especially as long as this branch of the work remains optional. There is a growing tendency, however, partly due to economic factors, to treat Agriculture as any other subject in the school curriculum.

4. Qualification and Preparation of Teachers.

In all of the Normal Schools in Canada some attention is given to the training of teachers in school Agriculture. In all but two of the provinces Summer Schools of from 4 to 5 weeks duration are conducted where special courses in Rural Science or Agriculture are offered. Attendance at these schools is optional and only a comparatively small proportion of the teachers have yet taken the courses offered.

Conclusions

Teachers throughout Canada are not being adequately prepared to teach Agriculture efficiently. Those who have studied Agriculture for two or more years in High School before going into teaching do better work in handling the Agricultural Course in the Public schools. More assistance should be given along the line of improved preparation for teachers, not only in the Normal School, but also subsequently in their own schools. The District Supervisor system meets this latter need to a large degree. Teachers require not only more and better training in the subject of Agriculture itself, but also in the best methods of correlating it with other school subjects in order to give emphasis to its educational rather than its vocational aspect.

Organization and Management of School Fairs.

Although of comparatively recent origin chool Fairs have become well established in l of the Provinces. In five of the Provinces e Fairs are organized regularly by officials the Provincial Departments of Agriculture orking in conjunction with various local ganizations and with teachers and School spectors. In the remaining four provinces icials of the Departments of Education in operation with teachers, School Boards, omen's Institutes, Agricultural Societies, ural Education Associations, etc., organize d conduct the Fairs.

The funds for meeting the prize lists are cured from various sources. Sometimes Pro-ncial Departments of Agriculture provide a ortion (usually about 40%) of the prize oney, and sometimes Departments of Educa-on make grants for the same purpose. In most if not all cases various local organiza-ons provide more than 50% of the funds quired for prizes. Five of the provinces vor holding the school fairs separately, some r account of the fact that the Agricultural airs are held too early in the season. In e remaining provinces some School Fairs e held separately and some in conjunction ith Fall Fairs.

Conclusions

The giving of large cash prizes to child-n who make exhibits at School Fairs should discouraged as tending to commercialize hat was intended to be an educational ency in the schools and in the community. he popularity of the School Fair in some stricts is waning largely on this account. one Province the experiment of awarding bbons and certificates as emblems of hon-able achievement and of merit instead of sh prizes is now being tried out. In any se it is desirable that school exhibitions ould fairly represent all the school and re-ted home activities of the pupils. It is im-ortant that general school work as well as ricultural production projects should be presented.

School sports, singing, public speaking, ysical training, project demonstration and geantry add greatly to the value as well to the interest of the School Fair.

The organization of School Fairs of this type should come under the general direction and control of Departments of Education and they can best be managed by the teachers themselves, aided by such local organizations as are interested in the work.

6. Organization and Management of Boys' and Girls' Clubs.

In six of the Provinces the responsibility for the organization and management of clubs rests with their respective Departments of Agriculture. In the remaining three the responsibility rests with the Departments of Education.

In most of the provinces the live stock branch of the Dominion Department of Agriculture gives assistance in organizing big clubs on something of a commercial basis.

It is generally true that those organizations that are concerned in club work also function in connection with School Fairs, although this is not necessarily the case. Agricultural College officials frequently give assistance in the work of inspection and commonly act as judges of agricultural exhibits at School Fairs. On occasion they also prepare special circulars for distribution to club members.

The local teacher is frequently Club organizer in her district and in one or two of the Provinces the School Inspector is charged with considerable executive work, especially in connection with the School Fair. In one Province the District supervisors of Agricultural Instruction as well as the District Agriculturists take the lead in their respective districts in organizing clubs and in managing School Fairs.

The problem of regular inspection and effective instruction presents some difficulty in most of the Provinces. Where clubs are organized by District Supervisors instruction is frequent and thorough. In one Province six men are engaged for six weeks and devote their time entirely to this work. Instructors in Agricultural Schools sometimes assist and District Representatives usually devote a good deal of time to this important part of Club work.

Conclusions

The main purpose and the essential character of Club work needs to be re-defined. There is a tendency on the part of some organizations, including the various breed associations, to exploit the boys and girls of the schools. The upbulding of a strong and noble manhood and womanhood is frequently obscured by the zeal of live stock breeders for the ascendency of their favorite breed, and the real club features are forgotten. Utility in education and education through utility are the real objectives in all Club and School Fair work. This work should have definite relation to the whole course of study and as such should come under the direction of the Provincial Departments of Education. Special Production clubs for older boys, such as Junior Farmers' Clubs should on the other hand be organized and directed by Provincial Departments of Agriculture. Agricultural Colleges can and should render expert assistance in both cases.

B. High Schools.

1. Status of Agriculture in the Curriculum.

All the provinces with one exception provide for the teaching of Agriculture in one or more grades of the High School. In three of the Provinces it is a compulsory subject in two grades and in one province in three grades. In seven out of the nine provinces it is now a subject for Matriculation and for Entrance to Normal School. In four of the Provinces it either follows a course in general science or is carried on simultaneously with it.

Conclusions

The tendency to require some science training for all students during their High School course is steadily growing and Agriculture as a Science subject is making rapid progress in most Canadian High Schools. A course in General Science and Agriculture, covering a period of three years should be compulsory for all students preparatory to entering the Normal Schools.

2. Character and Scope of the Work.

The Agricultural Curricula of the various provinces exhibit wide variation in the character and extent of the work prescribed. In some instances the subject matter contained in a single text-book of small dimensions such as Bailey's Botany or Brittain's Elementary Agriculture is prescribed but in most of the provinces a fairly comprehensive outline of agricultural topics is supplied.

Conclusions

Whilst some of the provinces seem to attach but little importance to the teaching of Agriculture in their High Schools, have allowed so little credit for it and have generally left it so poorly provided for as to bring it into the realm of contempt, other provinces have given the subject equal rank in the curriculum with other subjects. The standard of agriculture in all High School courses should be held on as high a plane as that given to any other Science subject.

3. Organization and Support.

Generally speaking, instruction in High School Agriculture is given in the usual way by teachers appointed and paid by School Boards. In some cases, this instruction is supplemented by special lectures and demonstrations given by Agricultural College professors or other trained agriculturists. In only two of the provinces are special grants made to School Boards towards meeting the expenses incurred in conducting the work. In one of these, the maximum grant allowed is $300 per year to each High School conducting the full two-year course. In this same province, part of the duty of the District Supervisor of Agricultural Instruction is the teaching of agriculture in the central High School of his district or municipality. 50% of the salary and travelling expenses of the District Supervisor is paid by the School Board concerned to the Education Department. The District Supervisors are officials of the Department of Education just as District Representatives or Agriculturists are officials of Provincial Departments of Agriculture.

Conclusions

If the future prosperity of Canada is to any extent dependent upon scientific agricultural development, there should be a greater concentration of effort on the part of all educational authorities in the matter of providing

quate instruction in the fundamentals of science. Agricultural courses if properly given, call for considerable expenditure for agricultural laboratory equipment and the operation of experimental and demonstration gardens. School Boards therefore, which attempt to provide thorough instruction in the subject may reasonably claim and would readily receive special financial assistance from governmental sources — Federal as well as Provincial.

Qualification and Preparation of Teachers.

The qualifications required for instructors in agriculture in High Schools are quite variable. In four or five of the Provinces, agricultural graduates are sometimes employed as High School teachers and as such, devote most of their time to the teaching of agriculture and other sciences. Only one Province requires that the subject shall be taught by graduates only. In one or two of the provinces, science teachers are given two summer courses in agriculture at an Agricultural College and are then certificated as instructors in High School Agriculture.

In only one of the Canadian Agricultural Colleges is any attempt being made to give a professional course in Education to undergraduates in agriculture. A few agricultural graduates have had professional training as teachers, obtained either in Normal Schools previous to entering upon their agricultural courses or in Faculties of Education after having completed them.

Conclusions

In order to secure the best results in the teaching of High School Agriculture, agricultural graduates are required and all such graduates should have professional training in Education. It is becoming increasingly important that Agricultural Colleges and Faculties of Education get together on this question and do something to meet the growing need for fully trained agricultural teachers for our High and Vocational Schools.

Special or Extension Courses.

Up to the present almost nothing has been done throughout the whole Dominion to provide suitable winter or term courses in Agriculture, Home Economics and other appropriate subjects for boys and girls of teen age who are not regular full time high school students. A small beginning along this line is reported from two Provinces. In one of these, successful night school classes in Agriculture have also been reported. This statement does not refer to agricultural short courses for farmers.

Conclusions

There is a large and highly important educational field now needing attention and as yet practically untouched. It is concerned with the problem of the out-of-school boy and girl in towns and country places. Winter term or part-time day schools should be opened, concentrating on Agriculture and Household Science, but also including other topics of more general educational interest. High Schools and school equipment should be made available for the accommodation of these special or extension classes. Whilst under the immediate direction of local educational authorities, these winter extension schools should have the support of all who have the welfare of Canadian rural life at heart.

6. Method and Equipment.

Only three of the Provinces report the general use of demonstration plots in the teaching of agriculture either at school or at the pupils' homes. In most cases, this practical and semi-experimental work remains optional with teacher and pupils. In two of the Provinces only is this method of instruction compulsory. Specially equipped agricultural class rooms are the exception and only one Province is fully equipped in this respect, while two report partial equipment. In some cases, the regular science laboratory is used for classes in agriculture.

Conclusions

Practical demonstration work must be regarded as an essential feature of all High School courses in Agriculture and ample provision should be made for it. Home project work should supplement class room instruction. School excursions for the study of practical agricultural problems and for the observation and judging of farm animals should constitute an important feature of the agricultural program in every High School.

7. Text Books.

Only three of the Provinces report the use of definite text books on Agriculture for use in High Schools. The books quoted are Brittain's Elementary Agriculture and Bailey's Botany. The majority of the Provinces have submitted detailed outlines of agricultural topics and are opposed to the placing of a text book on agriculture in the hands of the pupils. Some schools are well provided with reference books in almost all branches of agriculture, also current agricultural journals and numerous bulletins from foreign countries as well as from Canada.

Conclusions

It seems to be the concensus of opinion that there are few advantages and many dangers and disadvantages in using prescribed text books in agriculture in either public or High Schools.

PART II.

Agricultural Schools.

Your Sub-Committee on Educational Policies in Agricultural Schools beg to report as follows:—

1. Relationships.

The Agricultural Schools are under the direct supervision of Provincial Departments of Agriculture. They have no connection with the Departments of Education, nor do they sustain any direct relation to the Faculties of the respective Colleges of Agriculture.

2. Objects of an Agricultural School Course.

The courses in the Agricultural Schools are designed to train young men to be efficient farmers, and to equip young women to become successful home-makers. In addition to stressing the purely vocational aspects of Agriculture and of Home Economics, these courses are planned with a view to affording additional educational oportunities to those young men and women who, through force of circumstances, have not been able to obtain more than a public school education. A further object, as illustrated in two of the schools, is to prepare young men and women for entrance to the degree courses in Agriculture and Household Science respectively.

3. Entrance Requirements.

No special educational standing is required for admission to the Agricultural Schools; but practical experience in farming is a prerequisite.

4. Some Particulars Regarding Courses Offered.

The Courses extend over a period of two years and include two sessions of five months each. These sessions are held during the fall and winter months. Except under very special circumstances, students are required to take all the prescribed subjects. In two of the schools the time is evenly divided between lectures and laboratory work, the latter including farm practice; in another school sixty per cent of the time is devoted to lectures. It is not possible to state definitely the relative amount of time devoted to farm and laboratory practice as the proportion in the different schools varies from time to time.

5. Provision for Entrance to the Degree Course.

Credit towards the B.S.A. degree is allowed by two of the English-speaking Colleges for work done in the Agricultural Schools. In one of these cases, a non-matriculated student who completes the Agricultural School Course is eligible, upon the recommendation of his instructors, to enter the intermediate year in the Agricultural College. In the other case, a non-matriculant who wishes to enter the degree course must complete the two year course in the Agricultural School and obtain matriculation standing before being allowed to enter the second year in the Faculty of Agriculture. In this latter case, credit is allowed toward matriculation for three of the subjects taken in the school. Again, a matriculant who has completed one year's work in an arranged course in this Agricultural School is eligible to enter the second year of the degree course. Two of the schools have recently added a third year in order to provide instruction in all matriculation subjects whether students intend to enter the College of Agriculture or not.

6. Recent and Contemplated Changes.

In recent years, the most important changes made in these courses is the addition of a third year in two of the schools to meet the

mand for instruction in matriculation sub-cts. In one school, foreign students who e not conversant with English are allowed substitute English and practical subjects r some of the scientific ones. In another hool, a change from a one-year to a two-ar course in Household Science is contem-ated in order to allow a greater opportun-for the study of English and of agricul-ral subjects.

Conclusion

Your Committee has not attempted to ther data which would enable them to con-ude as to whether the undoubted useful-ss of these Agricultural Schools would be creased by a closer articulation with other ricultural agencies, or whether they might t attain an even greater measure of suc-ss were they to restrict their efforts to those tivities which are largely of a vocational ture.

PART III.

Agricultural Colleges.

Report of the Committee on Educational olicies in Agricultural Colleges:

RELATIONSHIPS.

Relation of the Colleges to the Provincial Departments of Agriculture.

In two of the Provinces, the Agricultural llege forms an integral part of the De-rtment of Agriculture; in all other Prov-ces, the College of Agriculture, through the verning bodies of the University, is direct-responsible to the Minister of Education to the Lieutenant-Governor in Council, as e case may be.

The present tendency is to make Colleges Agriculture constitutionally independent of partments of Agriculture but to encourage cial cooperation.

Relation of the Colleges to the Provincial Departments of Education.

Unlike the older Colleges of Agriculture ich were organized as an integral part of Provincial Department of Agriculture, the more recently established colleges ve been made directly responsible through ir respective governing bodies to the Min-er of Education, or to the Lieutenant-vernor in Council, as the case may be.

Relation of the Colleges to the Universities.

In the majority of cases, Colleges of Agriculture sustain the same relation to, and enjoy the same representation on, the governing bodies of their respective Universities as do other Faculties. Broadly speaking, this is true whether the Colleges are state supported or privately endowed, whether affilated with a university or a faculty of it, whether located at considerable distance or situated on the same campus.

While, in addition to the usual representation on the government bodies of the University, two of the Colleges of Agriculture have Advisory Councils composed of outside representatives of agricultural interests, the tendency is for Colleges of Agriculture to assume the same relations to the University as do other Faculties.

Conclusion

In the organization of Colleges of Agriculture the trend, as evidenced by the more recently established Colleges, is to have them constitutionally independent of the Provincial Departments of Agriculture, and directly responsible through their respective governing bodies to the Minister of Education, or to the Lieutenant-Governor in Council, as the case may be. With few exceptions, the relationship they sustain to their respective Universities is the same as that enjoyed by any other faculty.

2. EXTENSION AND SHORT COURSES—A GENERAL STATEMENT.

These courses are eminently practical. They deal with those branches of agriculture which are of vital interest to the farmer and so meet the special need of those who cannot, by reason of circumstances, avail themselves of the more extended and technical courses. No entrance requirements are demanded, and no written examinations are held.

All the colleges devote considerable time to Extension and Short Course Work; but on account of the wide variation in local needs and requirements it has not been deemed advisable, at this time, to make a detailed study of this important phase of educational activity.

3. Associate Courses.

Objects of an Associate Course.

The principal object of this course is to train young men for farm life. The subjects to be studied are selected with a view to preparing students to engage intelligently and successfully in the work of practical farming. Just enough science is given to enable them to appreciate its relation to general agricultural processes and practices. At the same time, sufficient attention is devoted to the more general subjects to the end that a taste for good reading may be cultivated and that a desire to become good citizens, as well as progressive farmers, may be strengthened.

There does not appear to be any pressing demand for the organization of new associate courses or for the extending of the scope of those now being given.

Entrance Requirements

No entrance examination is required, but the student must give evidence of having acquired sufficient knowledge and ability to profit by the instruction offered. One season's experience in practical farming operations is usually demanded as a minimum on entering the course.

Comparison of Courses Offered.

Of the eight Colleges of Agriculture which offer degree work, four also offer associate courses. Such courses vary in length from two to three years. In two instances, part of the associate work is recognized in the event of the student qualifying for admission to the junior year of the degree course, or to the intermediate year, as the case may be. In the remaining cases, the associate courses are separate and distinct from the degree courses and no credit towards the latter is granted.

In one College which confines its work to two years of instruction, the students are divided into two divisions—the 'Farm Division' and 'Scholastic Division'. As the standard for the latter is much higher than for the former, students who obtain the 'Scholastic Diploma' frequently continue their work in a degree-conferring institution.

Relation of Required to Elective Subjects

Elective subjects, as a rule, are not offered in the associate courses. Practically all the subjects are required.

Relative Time Devoted to Lectures and to Laboratory Work.

There does not apear to be any fixed relation between the time devoted to lectures and the time spent in laboratory work.

Conclusion

No important changes have been made in the associate courses since the practice of making a sharp distinction between the requirements for degree students and those for associate students have become general.

There are no indications that, for the present, any pronounced changes are being contemplated.

4. Degree Courses.

Objects of a Degree Course

The objects of a degree course are to give advanced instruction in distinctly agricultural subjects, in cognate sciences and in such elements of a liberal education as will equip the graduate for farming or for any related business or profession where a college education is advantageous.

The degree courses are not designed solely, or even primarily, for such graduates as intend to engage in practical agriculture. The training of agricultural teachers, investigators, journalists, administrators and publicists is as legitimate and as necessary a function of an agricultural college as is the training of graduates who make farming their life work. Men who have been educated in an agricultural environment, who have an agricultural outlook and a sympathetic understanding of the needs of rural life, are quite as necessary to the welfare of the State as are graduates who return to the farm.

Matriculation Standards for Degree Courses.

The matriculation standards demanded by Colleges of Agriculture differ widely. In certain Provinces, three years in the high school are required to obtain Junior Matriculation standing. Where this is so, there is little probability that this period will be extended to four years in the immediate future.

The practice adopted by some Agricultural Colleges of allowing wide latitude in the matter of "equivalents" is one which calls for the exercise of more than usual care if the standards for entrance to agriculture are to be maintained on a par with those of other Faculties in the University. All are agreed that prospective students in agriculture are entitled to as generous treatment in the matter of "equivalents" as are condidates for admission to other Faculties; but all are not agreed that they are entitled to more.

In the French-speaking Colleges, the minimum requirement for admission to the degree course in agriculture is the B.L. degree.

An increasingly large number of the English-speaking Colleges now require Junior Matriculation, or its full equivalent, of all students who enter the degree course. In the French-speaking Colleges, there is a growing sentiment in favour of requiring the B.A. degree for entrance to this course.

Entrance Requirements for Students not Having Matriculation Standing.

In several Colleges, application for admission to the degree course in agriculture, if made by a prospective student with defective matriculation standing, will not be granted unless the case comes within the general university regulations which apply to all faculties alike.

In one College such a student will be admitted, provided he is twenty-one years of age, possesses substantial farm experience and gives promise of having ability to carry degree work. He would be required, however, to obtain full matriculation standing before being allowed to enter upon the third year.

In another College, a non-matriculant who has attained a fairly high standard of proficiency in the Associate Course would be eligible to proceed to the third year of the Degree Course as soon as he has obtained his Junior Matriculation, or has completed the work of the intermediate year. The subjects taken in the 'intermediate year' consist largely of the scientific subjects of the first and second years of the degree course and are regarded by the Faculty as the equivalent of Junior Matriculation.

Notwithstanding these exceptions, the present tendency, as previously stated, is to require at least matriculation standing.

Practical Experience Required.

Usually the minimum practical farm experience required of a degree student is one full season's work on a farm from seedtime to harvest. One College requires a full year's apprenticeship, and one insists that in two of its options, graduates must have had at least three years, or the equivalent, of practical experience.

All the Colleges recognize the desirability of students having practical farm experience. Some insist that this experience be obtained before entering the College; others that it be had before beginning the second year, while still others have no requirement in this regard.

Length of the Undergraduate Course.

In one College, where the academic year is short, five years are required for a Junior Matriculant to complete the B.S.A. degree. All the other English-speaking Colleges require four years. In the French-speaking Colleges it is necessary for all students, including those who hold the B.A. degree, to take four years of undergraduate work in agriculture before being granted the B.S.A. degree.

There does not appear to be any considerable body of opinion in favour of extending the undergraduate course from four years to five.

Humanistic and Scientific Courses.

For the purpose of discussion, the subjects in the humanities and pure science are defined as academic.

In some of the Colleges, the division of time as between the academic and the strictly agricultural subjects is almost equal. One of the Colleges devotes almost all of the time of the first and second years to academic subjects, while another almost reverses this order in the first year.

In general, it may be said that the greater part of the first two years is devoted to academic courses which are compulsory for all. Present indications are that this trend will become even more pronounced.

Elective Courses.

In a number of the Colleges, no provision is made for elective courses. In other Colleges, the principle of electives is recognized, but the time available for them is almost

negligible. Two Colleges have developed the elective system quite highly in the junior and senior years.

The general tendency would appear to be in the direction of the gradual adoption of the principle of electives for the junior and senior years.

Combined Courses.

Three of the Colleges have adopted the principle of combined courses—one giving the B.Sc. degree, and two giving a double degree of B.A., B.Sc.

Certain institutions offering such instruction have no students registered, as yet, for these courses.

Degree of Specialization.

As a general rule, specialization begins in the third year and is intensified in the fourth. In one College, specialization is restricted—one subject excepted—to the final year; in another it is confined to the fourth and fifth years.

Several institutions which provide for a measure of specialization are considering the advisability of reducing the amount of time at present devoted to this purpose. One College which offers some specialization is seriously considering discontinuing it in its undergraduate courses, while another College has never adopted the principle.

There is a growing feeling in several of the Colleges that they have developed specialization too highly, with the result that their students have not received that thorough grounding in the principles and practices of general agriculture which should precede intensive specialization.

Relative Time Devoted to Lectures and to Laboratory Work.

While the length of lecture periods is practically the same in all the Colleges, the length of laboratory periods differs widely, being twice as long in some institutions as in others.

Roughly, the total time may be said to be fairly evenly divided between these two methods of instruction at all the Colleges. A careful study of the time-tables indicates that there is no unanimity of opinion with regard to the relative importance of these two methods, or to the order of their precedence during any given period of the undergraduate course.

The only tendency discernible is a slight one in the direction of an increase in the relative amount of laboratory work.

Proportion of Time Allotted to Reading and Library Reference.

Up to the present, no College has assigned periods in its time-table for reading and for library reference work, aside from those required for seminars and theses. One College has reduced the number of its lectures and laboratory periods slightly, and one has reduced them very considerably, in order to allow more time for reading and library reference.

This trend is one which commends itself from an educational, and also from a financial point of view.

Conclusion.

Recent changes in degree courses, when considered in connection with the tendencies already noted, indicate that those charged with the responsibility for formulating the educational policies of the Colleges of Agriculture are making an honest effort to adjust the courses of study to meet the present requirements: Entrance standards are being raised; undergraduate courses are being strengthened; provision is being made for advanced instruction; purely informative courses are being replaced by facilities and opportunities for acquiring a broader mental development; and, perhaps, above all, there is a fuller, freer and more frank recognition of the obligations of the Colleges to meet the needs of the student and of the State.

Suggested Recommendation.

This concludes the report of your Committee on Educational Policies for the year 1923-24. After the information had been brought together, the question arose as to whether your Committee should report their findings with or without formal recommendations. The decision reached by the members was that the study has not been sufficiently exhaustive to warrant specific recommendations being made to the Convention at this meeting. Your Committee begs respectfully to suggest however, that provision be made by this Convention for the continuation of these studies. This may make possible the preparation of definite recommendations for submission to the 1925 Convention.

Soil Moisture Investigations in Canada.*

E. S. HOPKINS

Dominion Field Husbandman, Central Experimental Farm, Ottawa.

One of the most outstanding facts in Canadian agriculture is the wide variations which occur from year to year in the yield of wheat in the Prairie Provinces. In Eastern Canada the variations in yield are not so extreme and, moreover, as 54 per cent of the cultivated area is in hay and intertilled crops, which may be good when the grain is poor, the yearly returns from the farm are much more uniform. On the three prairie provinces, however, where 92 per cent of the cropped area is in grain much depends upon the success of the grain. If the wheat is a failure, the farmer receives very little money and is often forced to reduce his standard of living. Persons who have business with farmers, storekeepers in rural communities, dealers and implement companies are also forced into bad circumstances. It is no wonder that everybody is happy on the prairie when the rains are timely and abundant.

PROVINCIAL YIELDS OF WHEAT PER ACRE IN BUSHELS

	Ontario	Manitoba	Saskatchewan	Alberta
1923	17.4	11.25	19.75	28.00
1922	16.9	19.25	20.25	11.25
1921	12.5	11.10	13.70	10.20
1920	16.8	13.90	11.20	20.50
1919	15.6	14.20	8.50	8.00
1918	23.25	16.20	10.00	6.00
1917	19.5	16.70	14.20	18.20
1916	11.25	10.90	16.30	24.90
1915	22.36	28.80	28.50	32.70
1914	18.80	14.70	13.70	21.00
1913	19.66	19.00	21.30	23.00
1912	18.77	22.20	19.20	21.50
1911	17.25	20.20	20.70	21.60
1910	17.92	12.30	15.80	10.00
1909	16.50	17.30	22.10	19.00
1908	15.50	17.30	13.60	18.80
1907	17.10	14.20	13.50	18.20
1906	19.00	20.00	21.40	23.10
1905	18.80	21.70	23.10	21.50
Average 19 years	17.90	16.90	17.20	18.80
Highest average 5 yr-period	20.0	21.0	20.7	24.6
Lowest average 5 yr-period	15.8	13.9	11.5	11.1

In order to show extremes of yields it may be interesting to give the yields each year on the three prairie provinces since 1905 and, for comparison, the yields in the province of Ontario. It should be remembered that the three prairie provinces produce 95 per cent of all the wheat grown in Canada.

It will be seen from the foregoing figures that the provincial yields of wheat in Alberta have varied all the way from 6.0 bushels in 1918 to 32.7 bushels in 1915. In Saskatchewan the variation has been from 8.5 to 28.5 bushels while in Manitoba the variation has been from 10.9 to 28.8 bushels. Ontario, on the other hand, has only varied from 12.5 bushels to 23.2 bushels.

Not only do individual years show wide variations but the average yields over a period of five years also show wide extremes. If a man started farming in Alberta in 1912 and received for five years up to 1916 the same yields as the provincial averages, he would have averaged 24.6 bushels of wheat per acre but if he had started in 1918 he would have received an average of only 11.1 bushels per acre. In the one case he would enjoy prosperity while in the other he would have lost money. In Saskatchewan, the average yield from 1911 to 1915 was 20.7 bushels per acre while from 1917 to 1921 it was only 11.5 bushels. In Manitoba the average yield from 1911 to 1915 was 21.0 bushels while from 1919 to 1923 it was 13.9 bushels per acre. In Ontario the highest five year average was 20.0 bushels while the lowest was 15.8 bushels per acre.

It will be remembered, moreover, that only provincial average figures have been given and that there are districts in each province which

* Paper presented at the Fourth Annual Convention of the C.S.T.A.

do not give as large yields as other districts. Furthermore, provincial average figures are more uniform than yields from separate districts owing to the fact that when there is a poor yield in one locality there is often a fair yield in another.

A study of these figures shows that the average yield throughout a period of 19 years has been very satisfactory on the prairie provinces but that this average yield is made up of very wide extremes. Furthermore, in Saskatchewan and Alberta, even five year periods may give average yields only one-half as much as other five year periods. It is during such poor years that the returns from farming become very bad and every effort is made to correct the trouble. Fortunately, compared with the other wheat-exporting countries, the average yields in Canada are considerably higher. The following figures show the average yields of wheat in the chief wheat-exporting countries of the world. These average yields cover the last twenty-three years for all the countries except Russia, which are for fifteen years.

Canada:	17.8	bushels per acre
United States	14.1	" " "
India	11.3	" " "
Australia	10.6	" " "
Russia:	9.4	" " "

To some extent these bad years are due to rust, particularly in Manitoba and in some parts of Saskatchewan, the rust problem not affecting Alberta, but by all means the most important cause is drought. It is for this reason, therefore, that the Dominion Experimental Farm System is undertaking rather extensive experiments to discover, if possible, any method of farming which may overcome the disastrous effects of drought. There are other factors, it is true, which cause losses, such as rust, weeds, insect pests, etc., but the lack of sufficient or timely rainfall is the most potent factor. Western farming has many good points and it is, on the whole, more profitable than farming in Eastern Canada but the lack of soil moisture very frequently decreases the yields very seriously.

Field experiments have been conducted since the commencement of the Dominion Experimental Farm System. They were designed to learn what crops would prove the most satisfactory and what rotations and cultural methods would give the best results. Among the most striking examples of this work may be mentioned the discovery that the common hay crops used in Eastern Canada, such as timothy, red clover and alsike, would not succeed on the prairie. The Dominion Experimental Farms at Brandon and Indian Head, which were established at the time the country was being settled, were the first to call attention to this significant fact. Western rye and Brome grass were more drought resistant and were used to replace the other hay crops. Later, alfalfa and sweet clover have been introduced in some places with success.

Other striking examples of this field experimental work have been the discovery that corn would replace a summerfallow, giving a crop of corn and at the same time leaving the land in such condition that it would produce as large a crop of wheat the following year as would summerfallow and at the same time, on account of the corn stubble, prevent the land from blowing. Methods of handling summerfallow to secure the best results have been learned. In the early days, it was customary to wait until July 1 before plowing the summerfallow but now it is realized that the earlier the plowing is done the better will be the crop the following year.

The acreage in fall rye has increased considerably during the last few years. It does better than wheat on light land and it is not affected by rust. Last year on the Dominion Experimental Farm at Morden, Manitoba, Marquis wheat yielded on summerfallow land 17 bushels per acre being injured by rust, while fall rye yielded 33 bushels. It is difficult to know in what part of the rotation to seed fall rye. It does best, of course, on summerfallow but as wheat is worth more per bushel, the summerfallow land is usually reserved for the wheat crop. Besides if the rye precedes wheat it is very liable to volunteer in the wheat and lower the grade. Some have thought that the fall rye could be seeded in the spring along with the wheat but this has not proved satisfactory. Where seeded in the fall on the wheat stubble the fall rye often does well except in dry years or in dry regions. In dry regions the only safe place where it can be seeded is upon summerfallow.

Just recently we have had evidence that there appear to be some districts on the prairie where the summerfallow does not give very much increased yields over stubble land. On the Dominion Experimental Farm at Scott, Saskatchewan, the yield of wheat on summerfallow has been only slightly larger than on the stubble land. Taking the average of several areas over 11 years the yield on summerfallow has been 20.0 bushels while the yield on stubble has been 16.7 bushels, a difference of 3.3 bushels. At Lacombe, on the other hand, there has been a very marked difference in yield of 16.2 bushels in favor of the summerfallow land. It is possible, however, that the explanation of the failure of summerfallow land to yield considerably increased yields over stubble land may be due to the year of fallow being too dry to enable any moisture being stored.

It is not the object of this paper to relate the achievements of field experiments. They are well known and their value fully appreciated by the intelligent public. I merely mention a few things that already have been learned which relate to soil moisture and which show the success of improved cropping methods in combating drought.

Everything is not learned yet, by any means, in the quest to combat drought. Unfortunately, in extremely dry years, practically all crops are a failure. This point is not realized by many well-meaning people who believe that if the cultivation had been done well no failures would be suffered. There are some years, however, which are so dry that the yields of wheat are not worth cutting and threshing. Under such conditions it becomes imperative to make a more intensive study than can be done by field experiments alone in the hope that something may be found which will combat the drought more successfully.

The Dominion Experimental Farm System is attempting this on its farm at Swift Current, Saskatchewan. Experiments are being conducted under controlled conditions in order that definite comparisons may be made between various crops, rotations and cultural treatments. The experiments are being conducted in deep tanks 5 feet in depth and 5 inches in diameter. A few tanks of larger diameter are used for corn and sunflowers in order to provide an area equal to that which the corn plant is given in the field. The soil is dug from the ground in layers, each layer shovelled separately and replaced in the tanks so that all tanks will have absolutely uniform soil and subsoil conditions. Those who are familiar with field experiments know how variable field plot yields may be, even when all the cultural treatments and the soil surface appears uniform, and will realize how important it is to overcome this factor. We believe that this technique will overcome soil variation. Owing to the small area which enables only 25 plants of cereals and grasses being used per tank we are not yet aware what number of plants will be required to overcome the variation in individual plants but work is in progress to determine this point. As only one plant of corn, sunflower and potatoes is used per tank it is certain that variations will arise with these crops and we are not yet aware how many tanks will be required to overcome the variations in individual plants of this class of crops.

In order to make conditions in the tanks resemble field conditions insofar as wind and light are concerned a small area around each tank is seeded with the same crop as is used in the tank. A wire cage is used to protect the crops against hail and birds. The tanks are weighed regularly to learn the amount of moisture which the various crops have used.

Taking the average figures for the two years, 1921 and 1922, at Swift Current, it has taken 1221 pounds of water to produce 1 pound of wheat grain. This figure includes not only the transpiration but the evaporation as well. On this basis to produce a 20 bushel crop would require 6.5 inches of water or, expressed in another way, each inch of water would produce 3 bushels of wheat. It must be understood, however, that the time when the rain comes makes a profound difference upon its usefulness to the crop. It is not known absolutely the exact stage in the development of the crop that the rainfall is most beneficial but it appears to be about the time of heading.

The transpiration required to produce corn and potatoes is much less than that required to produce wheat. As the average of two

years it has required 333 pounds of water to produce one pound of the dry matter of the entire wheat plant (not the grain alone) while to produce corn it has required only 227 pounds. The potato tubers have required 236 pounds but unfortunately owing to the high cost of production they do not offer much opportunity for use as principal crop. Sunflowers have taken 340 pounds while alfalfa has taken 616. The hay crops unfortunately not only require more water to produce each pound of dry matter but require the rain earlier in the year. Frequently the seasonal summer rains do not arrive early enough to benefit the hay crops to as full an extent as they benefit the cereal crops. Corn and potatoes, on the other hand, utilize both early and late precipitation which is another good point in their favor.

It is gratifying to know that the average rainfall on the prairie is sufficient to produce very satisfactory crops especially of grain, corn and potatoes. It is reassuring also to know that the water requirement of wheat is less in the Canadian West than in the Western States. Briggs and Shantz working at Akron, Colorado, found the transpiration ratio for wheat to be 513 while our work at Swift Current showed a requirement of only 333 pounds of water to produce 1 pound of the dry matter of the entire wheat plant. This shows that the water requirement on the prairie is approximately only ⅗ of that in Colorado.

While it is useful to receive precipitation at any period of the year, the amount which falls in the growing season is by all means the most important. The months of May, June, July and August are the most important and while the amount which falls in the latter part of August will not be of value where the crop is harvested before that date, there is a certain amount of compensation received by April precipitation which is not taken into account.

The table below shows the average precipitation which has been received during this four month period at representative places on the prairie and also the highest and lowest average precipitation received in five consecutive years.

It will be seen from the above figures that the rainfall is usually quite sufficient for a good crop if it were to fall when it were needed. Unfortunately there are some very dry years when the rainfall is not sufficient and when it seems practically impossible to produce a crop. At Lethbridge, for example, in 1918 there was received during the four month period a total of only 3.47 inches while in 1919 only 5.50 inches were received, half of which came in May. At Scott in 1918 during this period only 4.32 inches were received while in 1919 only 5.10 inches were received, half of which came in August too late to do its maximum benefit. It should be remembered, moreover, that the production of straw is the first requirement of the soil moisture after which comes the development of the grain. It sometimes happens that the supply of moisture is exhausted by the time the crop starts to head in which case, unless moisture falls immediately, the yield is very light.

I am hopeful that our controlled experiments with different rotations may indicate which rotation is most economical in its use of the soil moisture. We shall be able to learn definitely their comparative value in this regard much more accurately than is possible under field conditions. We are studying the amount of moisture conserved by summerfallowing and by different methods of handling stubble. It has been abund-

TOTAL PRECIPITATION DURING MONTHS OF MAY, JUNE, JULY AND AUGUST.

	Average	Highest 5 yr. Precipitation		Lowest 5 yr. Precipitation	
Calgary	10.00	17.69	1899-1903	6.11	1918-1922
Edmonton	10.76	14.91	1911-1915	7.37	1883-1887
Saskatoon	8.56	10.35	1908-1912	7.15	1914-1918
Brandon	9.45	11.95	1901-1905	7.35	1914-1918
Qu'Appelle	10.51	13.64	1909-1913	8.47	1916-1920
Medicine Hat	7.31	11.29	1899-1903	4.36	1917-1921
Swift Current	9.08	12.05	1899-1903	6.18	1917-1921

odds to show whether comparisons are or are not significant. There are two methods, Bessel's and Peter's, that have been developed to calculate the probable errors from the observations themselves. The formulae for these no doubt are well known, but it may be well to state them here:

BESSEL'S FORMULA

Probable error for a single determination

$$P.E._s = \pm .6745 \sqrt{\frac{\Sigma d^2}{n-1}}$$

Probable error for a mean.....

$$P.E._m = \pm .6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$$

PETER'S FORMULA

Probable error for a single determination...

$$P.E._s = \pm .8453 \sqrt{\frac{\Sigma+d}{n(n-1)}}$$

Probable error for a mean.....

$$P.E._m = \pm .8453 \frac{\Sigma(+d)}{n\sqrt{n-1}}$$

In these formulae P.E.*s* and P.E.*m* stand for the probable error of a single determination and the probable error of a mean; d refers to the deviation of the different items from their mean; and n to the number of items. The sign Σ shows that the values d^2 and d are to be summed. The meaning of (+d) is that the deviations are summed without regard to sign. The results obtained from either method are very similar and for practical purposes either may be used.

Since these two methods are based on the observations themselves they will in many cases give high values for the probable errors since they include in their final values the results caused by systematic errors. By this we mean that if a series of plats are placed on land that is highly variable the yield for each plat may differ considerably from that of the other plats due to the nature of the field used. At one end of the field the fertility may be low, hence the yields will be low, and at the other end the reverse may be true. These deviations are due to systematic changes in the soil and cause large probable errors. For this reason the results obtained by using the formulae cited above are often misleading and have resulted in some instances in causing distrust of the usefulness of probable errors. In some cases they mask real differences and the workers have been inclined to consider the data as of little value or to discard the probable error. There are also other kinds of systematic errors such as may be caused by factors influencing the result in a definite direction.

What we as experimenters are interested in doing is to be able to compare the results of two treatments in different parts of the field or in different fields without having them influenced by the systematic errors. A writer signing himself "Student"(4) has developed a method for analyzing just such cases. His method, in brief, consists of pairing the different comparisons and then from the results thus obtained determine whether the average difference is significant. This depends upon the size of the mean and the variability of the several paired differences. The following illustration will make this clear, when two varieties, A and B, are compared:

Table 1

A	B	D (B-A or A-B)	D′	D′²
79.6	77.2	−2.4	9.5	90.25
49.7	53.5	3.8	3.3	10.89
46.5	66.1	19.6	12.5	156.25
63.8	65.8	2.0	5.1	26.01
42.4	52.4	10.0	2.9	8.41
47.7	57.3	9.6	2.5	6.25
		M= 7.1		6)298.06
				49.676667

$$\sqrt{49.676667} = 7.048$$

$$\frac{M}{S.D.} = Z = \frac{7.1}{7.048} = 1.007$$

P= .9628 Odds = 25.8: 1

The difference between B and A for each comparison is obtained and the average of these differences is then determined. This is found to be 7.1. The difference between each item in column D from the mean is then determined and set down in the column D′. The signs of each item and the mean

must be observed. The values in the D′ column are then squared and summed. This sum is divided by the number of observations and the square root extracted. This gives the standard deviation of the differences from their mean. The ratio of the mean to its standard deviation is then determined and this has been designated Z by "Student."

"Student" has developed a table to determine from the value for Z the probabilities or odds that the mean difference is significant.

Here the odds are 25.8: 1 that the mean difference (7.1 bushels) is significant. For significance of value the odds should be at least 30:1.

The application of "Student's" method presupposes that experiments are so conducted that pairing may be accomplished. This at once emphasizes the importance of frequent checks and frequent replications of the comparison plats.

This method is very useful since it may be applied to the results of different years or of different localities for the same year.

The application of the probable error concept will help us in several ways. First, it will help us in interpreting our results and predicting what may, under similar conditions, occur again. Second, it will help us in terminating experiments that have been conducted long enough to prove the point at issue. Third, it will help in planning new experiments.

Let us now consider the application of the probable error to the comparison between the yield of Kubanka and Marquis wheat (Table 2).

Here the first test shows a mean gain of 2.7 bushels in favor of Kubanka but the comparisons show considerable range from +10.0 in favor of Kubanka to –8.0 or a gain in favor of Marquis. The odds as calculated by "Student's" method that Kubanka is better than Marquis are only 10: 1. The second comparison shows similar results. In one year Kubanka was the better by 20.8 bushels while in another year Marquis was the better by 10.7 bushels. The mean gain in favor of Kubanka is 4.0 bushels but the odds are only 9: 1. The author concluded that in both cases Kubanka was better than Marquis. Such conclusions are hardly justified by the results and the most one can say is that the indications slightly favor Kubanka.

Table 2.

Comparison in Yield Between Kubanka and Marquis Wheats.

Yield Kubanka	Yield Marquis	Gain Kubanka over Marquis	Yield Kubanka	Yield Marquis	Gain Kubanka over Marquis
28.3	29.3	–1.0	2.0	12.7	–10.7
15.0	15.8	– .8	19.7	13.5	6.2
17.0	25.0	–8.0	33.3	33.3	0
11.4	7.2	4.2	12.2	6.4	5.8
17.4	14.7	2.7	15.2	11.4	3.8
30.8	23.3	7.5	12.9	20.9	–8.0
10.0	3.3	6.7	15.5	10.3	5.2
6.7	3.3	3.4	27.5	6.7	20.8
20.0	10.0	10.0	6.9	1.2	5.7
			29.2	18.3	10.9
	Mean gain	2.7		Mean gain	4.0
Odds that gain may be significant are only		10: 1			9: 1

Another experiment that has been published to which we may apply probable error is that of the rate for seeding oats. (Table 3).

The first comparison is that made between 5 and 9 pecks per acre. The experiment gives the results for ten tests and the mean gain was 2.97 bushels in favor of the higher rate of seeding. In two tests, however, the lower rate gave larger yields. Since the heavier rate of seeding required one bushel more seed this should be taken into account before the final comparison. The odds are only 13: 1 that there is a possible difference in favor of the thicker rate of seeding. When a similar comparison is made between 6 and 9 pecks we find that in three of the ten tests the lower rate gave the higher yield. The net gain is 1.23 bushels with odds of only 5: 1. With the comparison between 7 and 9 pecks the net mean is 1.01 bushels per acre and odds of only 4: 1. Three of the tests showed an increase for the thin seeding and in one test the yield for each rate was the same.

This table also illustrates the use that can be made of the probable error in analyzing the results of experiments after they have been underway and terminating many of them after a few years' results are obtained or after they have been conducted long enough to demonstrate the point involved. In each case the results of the first five tests

Table 3.

Showing the Application of Probable Error to the Rate of Seeding Oats.

pecks r acre	9 pecks per acre	D	6 pecks per acre	9 pecks per acre	D	7 pecks per acre	9 pecks per acre	D
41.44	47.03	5.59	39.64	47.03	7.39	43.35	47.03	3.68
50.16	50.16	0.00	52.34	50.16	–2.18	51.80	50.16	–1.64
55.08	59.59	4.51	56.25	59.59	3.34	56.02	59.59	3.57
41.56	46.17	4.61	42.19	46.17	3.98	44.30	46.17	1.87
70.23	69.92	– .31	72.27	69.92	–2.35	71.25	69.92	–1.33
64.18	68.47	4.29	67.46	68.47	1.01	68.47	68.47	0.00
42.50	37.11	–5.39	41.17	37.11	–4.06	41.48	37.11	–4.37
66.56	72.66	6.10	67.81	72.66	4.85	70.23	72.66	2.43
45.00	52.34	7.34	45.62	52.34	6.72	44.53	52.34	7.81
58.51	61.48	2.97	59.92	61.48	1.56	58.43	61.48	3.05
	Mean =	2.97		Mean =	2.03		Mean =	1.51
	Less 1 Bu.	1.00		Less	.75		Less	.50
		1.97			1.28			1.01
dds that gain may be significant								
are only		13:1		Odds are 5:1			Odds are 4:1	
esults of 5 tests								
	Net mean =	1.88	5 tests — Net mean =		1.29	5 tests — Net mean =		.73
dds that gain may be significant								
are only		9:1		Odds are 3:1			Odds are 3:1	

Table 4.

Rate of Seeding Test with Wheat.

VALLEY

Year	6 pecks per acre	8 pecks per acre	Year	6 pecks per acre	9 pecks per acre
1897	20.33	20.25	1897	20.33	20.08
1898	17.04	21.59	1898	17.04	21.54
1899	23.33	23.24	1899	23.33	26.16
1900	8.08	10.33	1900	8.08	9.56
1901	21.96	22.75	1901	21.96	21.00
1905	22.63	25.42	1905	22.63	24.29
Ave.	18.89	20.60	Ave	18.89	20.44
	Odds 27:1			Odds 16:1	

FULTZ

Year	6 pecks per acre	8 pecks per acre	Year	6 pecks per acre	9 pecks per acre
1901	19.88	20.83	1901	19.88	21.58
1902	23.58	24.33	1902	23.58	25.66
1903	35.17	35.00	1903	35.17	38.58
1904	14.56	16.95	1904	14.56	16.83
1907	32.21	32.66	1907	32.21	31.83
1908	41.04	39.96	1908	41.04	41.37
1910	35.37	34.71	1910	35.37	33.50
Ave.	28.83	29.21	Ave.	28.83	29.91
	Odds 3:1			Odds 11:1	

proved all that it was necessary to know regarding the experiment. The net mean in each of the first two comparisons is practically the same as for all the tests, and the odds are about the same. For the third comparison there is a slight difference in the net mean but the odds remain about the same.

There are many experiments of this sort where it is worth while to test out some method to determine what the best practice should be. These experiments if properly conducted and analyzed can be terminated after a few years and the money and land required devoted to other tests.

I do not mean at all that this can be done with all kinds of experiments for it is recognized that many experiments, for instance, soil tests, must be conducted for years and their value increases greatly with the years.

Another similar experiment may be cited where different rates of seeding wheat have been tested for several years. (Table 4). The only conparisons given are those between 6 pecks and 8 pecks and 6 pecks and 9 pecks. Two varieties were used. The results of all the tests show that in no case was there any real difference between the different rates. The conclusion was that 8 pecks gave the best yield with 9 pecks second and 6 third. Little can be said from these results in favor of either rate.

Another experiment which shows how the probable error may aid in analyzing the results and foretelling what may happen if the experiment is continued is given in table 5.

This shows first the comparison between two varieties of oats for four years. The average difference is 5.52 bushels and the odds are low, being only 5:1. One would conclude that there is very little difference between the yielding power of these two sorts. The experiment was continued and after nine years the average difference was .57 bushels and the odds 1:1. This shows that the conclusion based on the first four years was substantiated.

Table 5.

Use of Probable Error in Comparing Varieties and Showing Use of it in Prediction.

Year	National	American Banner	Difference
1912	84.8	66.2	18.6
1913	68.1	68.0	.1
1914	46.6	39.9	6.7
1915	77.1	80.4	-3.3
	69.15	63.62	
	Difference 5.52 Bushels – Odds 5:1		
1912	84.8	66.2	18.6
1913	68.1	68.0	.1
1914	46.6	39.9	6.7
1915	77.1	80.4	–3.3
1916	40.7	46.1	–5.4
1917	45.3	56.8	–11.5
1918	59.4	59.8	– .4
1919	43.0	42.6	.4
1920	48.9	49.0	– .1
	57.1	56.53	
	Difference .57 Bushels – Odds about 1:1		

The third application suggested, that of using the probable error in planning new experiments, may be demonstrated by the following results. In such cases it is necessary to know the variability of the material, such as plats, before an experiment is outlined. For example, if one is to lay out a new experimental field it will be worth while to determine the variability of the plats to be used. That is, the field may be divided into plats and all the plats planted to one crop. From the yields of the different plats one can calculate the probable error of a single plat. For such work to be of value it should continue for several years so that the different crops to be grown will all be planted on the plats. One point in this connection has not been proven and that is whether plats that show a certain variability for a few years will continue to react the same after the treatments have been begun. The following results from some of the soil fields at the Illinois Experiment Station will serve as an illustration. Just the yields of corn are given here.

Table 6.

Results of Illinois Soil Tests.

NO TREATMENT—CORN

lat	1895	1896	1897	Plat	1895	1896	1897	1901
01	30.0	87.9	69.0	301	30.0	89.6	64.7	43.6
02	29.1	89.5	68.6	302	32.9	88.2	69.9	44.4
03	25.7	89.8	67.5	303	26.9	85.1	67.6	47.8
04	26.3	94.8	66.6	304	32.9	92.0	73.2	54.7
05	30.3	96.9	67.5	305	38.6	99.4	78.3	54.4
06	31.1	99.5	66.8	306	32.9	97.0	75.6	54.0
07	37.1	94.6	69.9	307	31.4	95.2	77.3	53.5
08	34.6	92.7	68.4	308	31.4	100.1	75.4	56.0
09	34.3	103.9	66.9	309	35.7	99.9	71.4	56.6
10	36.3	102.2	68.5	310	33.7	98.4	72.6	55.6
. of singles	2.92	3.88	.81		1.94	4.11	2.99	3.62
. in per cent	9.27	4.08	1.19		5.95	4.35	4.12	6.96

These results show that there was considble variability in the fields especially from t 101 to 110. The probable error of a gle plat in per cent ranges from 1.19 to 7 per cent. The average probable error these and other similar plats before treatnt was begun was 6.64 per cent. This uld have been taken into account in plang the tests and later in interpreting the ults. In order to make a comparison been two plats the difference should have n at least twenty per cent, or at least ee times the probable error and four times probable error would be safer.

f new fields are to be laid out the probable or may aid in planning the new experints. In this case it will be necessary to ke a survey of the variability of the mal to be tested. By taking an average of ny tests a reliable figure can be obtained ich will furnish some indication of the nber of plats or tests to be grown. For mple, if a survey has shown that there a probable error of five per cent for a gle plat, then by using the following mula the number of plats to be used for one comparison may be determined:

$$\frac{\text{E. in per cent of mean}}{\sqrt{n}} = \frac{\text{Percentage difference to be measured}}{\text{Ratio that gives desired odds}}$$

$$\frac{5}{\sqrt{n}} = \frac{10}{4.51} = n = 5 \text{ plats}$$

Using the average of the Illinois results as 6, the number of plats would be 7.

It is best to have the required number of plats under test each year, but if this is not possible fewer plats may be used and the experiment continued several years. The author is not unmindful of the fact that many times it will be necessary, according to theory, to use a very large number of plats and that such a large number would be prohibitive on account of land and expense. The question then arising is whether one is not attempting to make comparisons that cannot be measured by ordinary experimental methods and whether such differences, being very small, are really worth measuring.

In this presentation an attempt has been made to show what the probable error is and how it may aid in planning experiments and interpreting their results. I would make a plea for a greater use of the probable error concept in all agronomic work. If experiments have been so conducted that it is impossible to calculate the probable error, let it be kept in mind that there is such a thing and that even if we have only one yield for a single plat it is a variable and should be so considered. It is especially urged that in laying out new experiments they be planned in accordance with our knowledge of the subject today. If this is done the literature of agronomic work will in the future contain less material of doubtful value and more that is sound.

In conclusion, it is well to state in brief what the probable error does. By its cal-

culation we determine whether any set of data is of sufficient value to warrant definite conclusions. The results may be such that in connection with their probable error they may be suggestive of certain facts, but do not prove them absolutely. If the points are not proven, as may be indicated by the probable error, it is possible to determine how many similar experiments must be conducted to prove the points and how many plats or animals, or trees, or what not, should be used in future experiments.

We learn from experiments the variability of the material in question and can plan new experiments in the light of the results of those already completed. Thus, the use of the probable error concept will aid us greatly in the new experimental work.

In this conection it may be said that it will not be possible for every worker, in whatever line he may be, to become thoroughly conversant with the technic of biometry. It is possible, however, for him to see wherein it will benefit his work and to appeal to those trained in its use. Each experiment station should look forward to having at least one investigator trained along these lines to serve in an advisory way relative to planning experiments and interpreting the results. It is admitted at once that such an arrangement may lead to complications. It is better, however, to have such complications occasionally than to continue to put out results inadequately analyzed, or to plan new experiments that cannot by their nature prove the points in question. This is very important in connection with planning new experiments. It seems that there should be no authorization of funds for projects that are not carefully planned in the light of present-day knowledge.

In answer to the criticism of some that the probable error cannot be applied to a small number of observations, it is well to add that if this is so we should place little dependence on a mean or other constant obtained from a few observations.

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CHILEAN NITRATE COMMITTEE PRIZES AWARDED

The prizes offered to Members of the C.S.T.A. by the Chilean Nitrate Committee for the best essays written on the rational use of Nitrate of Soda as a fertilizer, have been awarded as follows:

First Prize of $75.00 to Andrew Fulton, Assistant to Dominion Fruit Commissioner, Ottawa, Ontario.

Second Prize of $50.00 to Walter A. DeLong, Assistant in Chemistry, Macdonald College, P.Q.

Third Prize of $25.00 to Georges Gilbert, Experiment Station, St. Anne de la Pocatière, P.Q.

The essays were judged by Mr. B. Leslie Emslie, Director of the Chilean Nitrate Committee, Toronto; Mr. G. S. Peart, Chief of the Markets and Fertilizer Division of the Dominion Seed Branch, and the General Secretary of the C.S.T.A.

The essay written by Mr. Fulton will be published in the next issue of *Scientific Agriculture*.

Is the Apparent Winter-Killing of Sweet Clover and Red Clover a Result of Disease Injury?

R. NEWTON and W. R. BROWN

University of Alberta, Edmonton

On May 8, 1923, observations were made on plots of white sweet clover, in the experimental grounds of the Department of Field Husbandry, which had apparently suffered considerable winter-killing. The damage was found to have occurred in the root. The lower portion of the tap root in the killed plants was completely decayed away. In most cases, a portion at the top of the root, varying in length from ½ inch to 1½ inches, appeared fairly intact, and in some cases new growth was commencing from this portion. In other cases, fewer in number, the whole root was destroyed and the stem also damaged. Numerous round, black sclerotia, 1 mm. or less in diameter, were present in the injured portions, often thickly clustered on the surface. The appearance of the plants was such as to suggest very strongly that the injury was not due to frost but to infection by some species of *Sclerotinia*.

Red clover plants, examined at various times in early spring of the same year, were also found to have suffered most damage in the roots, the tenderest portion being just at the junction of the root and the crown. This portion had a diseased appearance. In many cases buds pushed out from the crown in early spring, but quickly perished because they had no root. If the death of the root is due to frost, the buds are evidently more frosthardy than the roots. Some plants which had been covered thickly with manure all winter were found in the same condition. We had been inclined to regard the decayed condition of the upper part of the root as a result of saprophytic infection following frost-killing of the cells, but the unmistakable evidence of parasitic injury in sweet clover raised the question of a possibly similar situation in red clover.

PLATE I.—Sweet clover and red clover in boxes of sterilized and unsterilized soil. September 19, 1923.

To check the foregoing observations and obtain further information, a preliminary experiment was carried out in the season of 1923-24. Fourteen boxes, each 4 feet long, 2 feet wide and 1 foot deep, were set into the ground and filled with soil taken from plots in which the clover plants had been heavily infected with sclerotinia that season. In the case of seven of the boxes, however, the soil was first sterilized in an autoclave, exposed in columns about 5 inches thick, for 1 hour after the steam pressure had reached 20 pounds. Altaswede clover was planted in six boxes, July 9, 1923, and white sweet clover in eight boxes, July 14, 1923. In both crops, the seedings were divided equally between sterilized and unsterilized boxes. All seed used was inoculated with infusions from root nodules of healthy plants, and in all cases the plants made vigorous growth. (Plate 1).

It must be pointed out that the sterilized boxes would, of course, be subject to gradual reinfection by soil blowing about, as the tops were open. Though our results must therefore be regarded as tentative until confirmed by more elaborate and carefully controlled investigation, it is felt that they are of sufficient importance to justify this preliminary experiment.

Careful observations, with the aid of a microscope, were made on plants withdrawn at intervals from both sterilized and unsterilized boxes, until they were covered with snow late in December. No trace of sclerotinia infection could, however, be observed. In the spring casual observation of the boxes suggested that both red and sweet clover had come through the winter fairly well. A critical examination conducted May 4 to 12, when all the plants from both sterilized and unsterilized boxes were removed and examined individually in the laboratory, told a quite different story. The observations, so far as it is possible to record them numerically, are given in Table I.

The first item in the table is the total number of plants found in each box. Approximately equal quantities of the same lot of seed were planted in sterilized and unsterilized boxes, but it appears that the sterilization so far changed the normal condition of the soil that a large percentage of seeds failed

TABLE I.—STATISTICAL REPORT ON EIGHT BOXES OF SWEET CLOVER AND SIX BOXES OF RED CLOVER, May 4-12, 1924.

	SWEET CLOVER								RED CLOVER							
	Unsterilized				Sterilized				Unsterilized				Sterilized			
	a.	b.	c.	d.	a.	b.	c.	d.	a.	b.	c.		a.	b.	c.	
Total number of plants	177	223	221	159	93	142	107	129	245	209	279		160	151	134	
Number showing injury	83	90	87	79	6	8	5	5	180	141	162		117	133	121	
Heavy	34	23	23	31	6	0	3	0	165	91	113		98	111	103	
Slight	49	67	64	48	0	8	2	5	15	50	49		19	22	18	
Number of healthy plants	94	133	134	80	87	134	102	124	65	68	117		43	18	13	
Percent injured	53.1	40.4	39.4	49.7	6.5	5.6	4.7	3.9	73.5	67.5	58.1		73.1	88.1	90.3	
Percent healthy	46.9	59.6	60.6	50.3	93.5	94.4	95.3	96.1	26.5	32.5	41.9		26.9	11.9	9.7	
Av. percent injured		45.7				5.2				66.4				83.8		
Av. percent healthy		54.3				94.8				33.6				16.2		

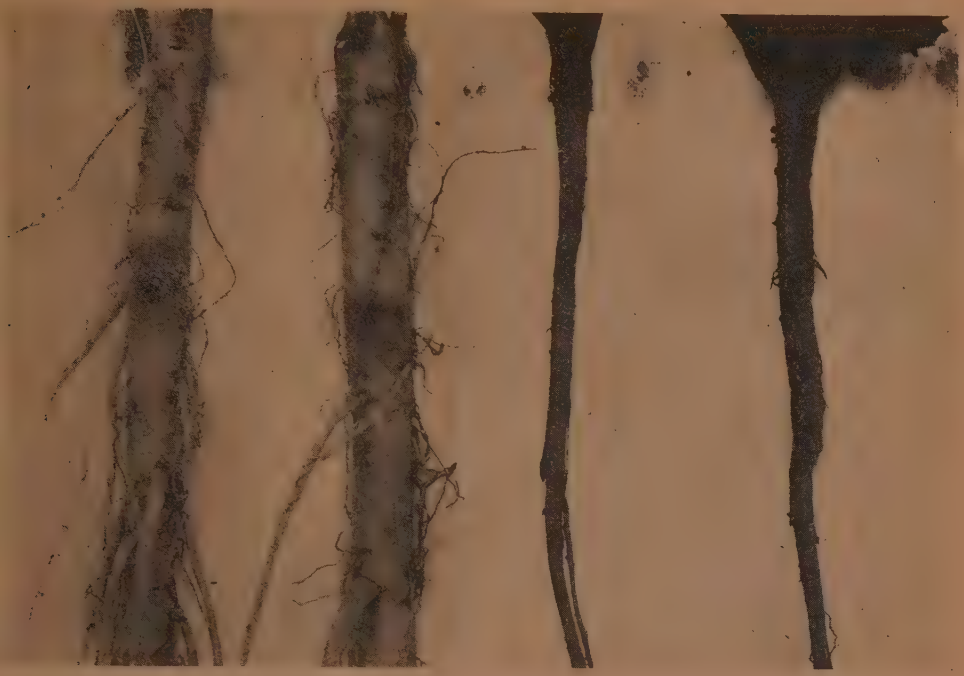


PLATE II—Typical injury. Note lesions on sweet clover roots (left) and withering of top of red clover roots (right). May 6, 1924.

o germinate or perished in the seedling stage. It is interesting to note also that this abnormal soil condition exerted a marked influence on the root development of the plants. The increased vigour and size, especially of the lateral roots (Plate IV), are greater than would be expected merely from the reduction in number of plants per unit area.

In addition to classifying the plants into those showing injury and those apparently healthy, the former group has been further subdivided according to the severity of the damage. Those plants in which the injury is described as slight would probably in most cases have survived; those heavily injured would likely in most cases have perished. It has been observed, however, that sweet clover plants show astonishing powers of recuperation. A stand of Grundy County sweet clover yielding an apparently normal crop, on examination (July 7, 1924) was found to consist chiefly of plants in which the tap roots had been completely severed by sclerotinia injury about an inch below the crown, but which had re-established themselves by sending out strong laterals above this point.

The usual type of injury in sweet clover and red clover is quite distinct. In the former slight injury may begin at the ends of the lateral roots, but severe injury is always accompanied by the appearance of characteristic lesions on the side of the tap root, usually about an inch below the surface. These lesions grow until they penetrate right through the root, and may finally involve the whole of the root, converting it into a light-brown, rotting mass. In red clover, on the other hand, injury begins usually at the very top of the tap root, which takes on a dark-brown withered appearance. (Plate II). In the latter case it is not possible to say at present whether the injury is due to disease or frost.

The figures in Table I, as well as our observations, tend to confirm our earlier conclusion that the injury to sweet clover, which had been supposed to be winter-killing, is due in fact to infection by sclerotinia. Sclerotia were found in large numbers in practically all injured plants. For red clover, on the other hand, the figures are entirely negative. That this result did not arise merely from failure to prevent reinfection of the soil is in-

dicated by our observation that sclerotia were present in large numbers, often in masses, in the dead plants of red clover from the unsterilized boxes (Plate III), while they could be found in very few cases in the dead plants from sterilized boxes. The lack of correlation between freedom from injury in red clover and soil sterilization, though the latter profoundly affected the prevalence of sclerotia in injured plants, suggests that in the case of red clover sclerotinia infection is not the primary cause of the apparent winter injury. However, it must be noted that in one unsterilized box of red clover we found eight plants showing injury abnormal for red clover but resembling typical sclerotinia injury of sweet clover. This disease may therefore be an important contributing factor to the sum total of the injury occurring in red clover.

It is clear that the problem deserves further investigation, and that the collaboration of a plant pathologist is essential.

ACKNOWLEDGEMENT

The foregoing experiment is part of a more extensive investigation of the nature of winter hardiness in crop plants, which is receiving the financial assistance of the Honorary Advisory Council for Scientific and Industrial Research.

PLATE III.—Advanced stage of disease, showing numerous sclerotia on red clover roots (left) and sweet clover roots (right). May 6, 1924.

Some Forage Crop Needs and Difficulties in Canada.*

G. P. McROSTIE

Central Experimental Farm, Ottawa, Ont.

The paper that I wish to present at this ne is of necessity general in character. No empt will be made to go into minute de- l with respect to the considerations brought rward. My object is rather to lay before u the forage crop situation as it exists in s country at the present time in so far as ave been able to interpret the signs of the nes correctly.

I will use the term forage crops as includ- g the various crops coming under the activi- s of the Forage Crop Division of the Dom- on Experimental Farms Branch. The neral types of crops included will there- re be as follows:

(a) *Hoed Crops*—Including field corn, sunflowers, field roots, artichokes, soy beans, etc.

(b) *Annual Hay and Pasture Crops*—Including grain varieties, millets, Sudan grass, Teff grass, Annual Sweet Clover, etc.

(c) *Biennial Hay and Pasture Crops*—Including Red Clover, Biennial Sweet Clover, etc.

(d) *Perennial Hay and Pasture Crops*—Including Perennial grasses and clovers, alfalfa, etc.

One of our serious problems in the carry- g out of forage crop improvement in Can- a, lies in the vast extent of territory which must serve. The problem in this con- ction is the division of this broad expanse agricultural land as definitely as possible o zones, with similar agricultural require- nts and of similar agricultural possibili- s. Anyone who has had the opportunity of velling through the potential agricultural eas of Canada will have some understand- g of the difficulties of such a task.

The Maritime Provinces, consisting of ince Edward Island, Nova Scotia and New unswick, with their comparatively low vations, fairly high humidity and under erage conditions sufficient rainfall, are on whole, quite well adapted to the grow- of most of the common forage crops. This is particularly true with regard to many varieties of field roots. Showery weather during harvest time frequently interferes with the production of fodder of the best quality. This is especially the case, with the coarser growing fodders as alfalfa and sweet clover.

The Provinces of Ontario and of Quebec present a wide range of agricultural variation in both soil and climate, varying from the warm sands of the Leamington districts of South Western Ontario with its light snowfalls and moderate winters to the extensive clay belts of Northern Ontario and Quebec with their long cold winters, heavy snowfalls and abundant summer growth. In common with the Maritime Provinces however, sufficient summer moisture is usually available throughout both provinces to produce Timothy, Red Clover, Alsike Clover and White Clover as well as the more drought resisting alfalfa and sweet clovers.

When we reach the provinces of Manitoba, Saskatchewan and Alberta, commonly known as the Prairie Provinces, we meet a condition where soil moisture is probably the chief limiting factor in connection with plant growth. Here for the most part Timothy, Red Clover, Alsike Clover and White Clovers do not produce paying crops of forage and are largely replaced by Western Rye, Awnless Brome Grass, Sweet Clover and Alfalfa in the non-irrigated areas devoted to the production of hay and pasture in the regular sequence of farm crops. In this section of Canada the various grain crops alone and in combination also constitute a common source of fodder for winter feeding and when handled with good judgment produce excellent feed.

The remaining province of Canada, namely British Columbia, presents the widest range of agricultural conditions within its bounds of any province in the Dominion. The mountainous nature of the province is largely responsible for this extreme variation in agricultural conditions. The coast regions

*Paper read before the meeting of the British Association for the Advancement of Science, Toronto, August, 1924.

especially in the southern portion of the province, have the mild climate common to the districts effected by the warm currents of the Pacific Ocean. The southern central valleys require irrigation for the most part to produce profitable crops, while some of the northern valleys have much the same cropping possibilities as Central Ontario.

In the portions of Canada where moisture seems to be the chief limiting factor in plant growth a problem, not equally important in the more humid areas, arises. This is the question of the residual effect of different forage crops available for the district in question. A reference to some results secured at our Experimental Station at Beaverlodge, Alta., will serve to illustrate the point at issue. During the past few years there have been grown at the Station mentioned plots of grasses commonly considered suitable for various sections of Canada. The residual effects of these grasses have been studied by observations and yield tests made with crops subsequently planted on the area formerly occupied by the grass plots of different kinds.

The crops secured from the soil previously occupied by Timothy have in all cases been the least profitable. In a year like the present one, when rainfall is exceptionally scanty the crops planted on former timothy sod are almost a complete failure. The least harmful residual influence was experienced subsequent to the Western Rye grass sod.

The extent and nature of this residual effect of our various grasses is a problem deserving considerable further study, as it has a very marked influence on the total revenue which may be derived from a given piece of land through any regular sequence of crop rotations.

Coming to the question of the forage plants themselves we find various problems arising because of the nature of the crops concerned. The fact that forage crops belong, with few exceptions, to the open fertilized group of plants, has discouraged and postponed the development of pure lines similar to those we find commonly among the self fertilized crops. As a consequence a confusing multiplicity of so called varieties and strains, but which are, in reality mixtures, exists to a degree sufficient to merit our serious considerations.

A reference to the corn crop will serve to illustrate my point. At our Experimental Station at Harrow, Ont., we have collected samples of seed from practically all sources offering seed corn for planting in Canada. Among these lots of seed we have certain varieties secured from widely scattered districts. We find differences occurring in the varieties thus secured which differences are in themselves more marked than the morphological variations used frequently as the chief points of distinction between the varieties themselves. Thus, if we recommend Longfellow Flint corn for a certain agricultural zone the value of our recommendation to the grower will depend on his securing, either by accident or design, seed of identically the same growth habits as the seed we have tested.

Not only have we essentially different strains of our varieties sold under a common name and without any differentiating symbol but we have also essentially the same varieties sold under a score of names. Thus we see that we are confronted with sins of both omission and commission.

A condition such as this, which unfortunately is not confined to Canadian Agriculture alone, in my opinion. points to the need of at least two courses of action tending to remedy existing practices.

One of these courses is the complete classification into well defined groups of our various kinds of forage crops. Such a classification would bring to light and record any variety under the various names by which it had been known to growers and would at the same time place it definitely in a group, the value of which could be established for each definite agricultural zone. The identification of any new introduction with any particular plant group would also at once give a fairly definite intimation of the agricultural zones in which it might prove valuable.

The second possibility in meeting the conditions that I mentioned previously is the separation of our various forage crop mixtures into their component strains where such is possible.

In my opinion, we have been too prone to magnify the difficulty of this purification process and perhaps to accept blindly the prevailing idea that the mixtures are better anyway when it comes to open fertilized plants.

It is undoubtedly true that not all individuals which go to make up the mixtures of forage crops now existing are of equal value. Some are high yielders of food value per acre while others are just as obviously undesirable in that respect. It surely should not be expecting too much to assume that

e removal of these poorer individuals will sult in a decided increase in both the qual- and quantity of the crop concerned.

The self fertilization of these open fertiliz- plants seems to be the most direct and pid way by which purification can be ought about.

The utilization of the inbreeding process d a definite study of the effects of this lf fertilization on the various open fertiliz- plants is one of the important problems nfronting the forage crop breeder of today. hat plants do not respond in the same man- r to inbreeding is obvious to anyone who as attempted such work. Some plants as ed Clover seem to be for the most part self erile, although even with the crop men- oned we are finding considerable variation the response to self fertilization, while hers although classified as open fertilized em to be fertilized by their own pollen in e great majority of cases.

The compatability of the male and female ements of any plant is an important con- deration in that it is a fair indication of hat may be the result of inbreeding with ny kind of crop. Where crossing normally ccurs to a much greater extent than self rtilization in the case of any plant, inbreed- g is likely to result in a marked decrease in ze of the inbred progeny. The sunflower lant furnishes us with an excellent example f this fact. Crossing occurs much more of- n than self fertilization in the case of the lant in question. In fact many sunflowers em to be practically self sterile but a fair ercentage produce viable seed when self fer- lized. At the Central Experimental Farm t Ottawa, we have nearly ten thousand sun- ower plants which are the progeny of par- nts that are the result of five generations of lf fertilization. Most of these inbred strains re much smaller in size than the commercial ots from which they were selected but they re remarkably uniform with regard to all istinguishable morphological characters and ary greatly with respect to the vigour and esirability of the individual strains. All resent indications point to the probability f a combination of the more desirable of ese strains of similar type, giving us a new ariety more uniform and much superior in ield and quality to the commercial mixture rom which these strains were selected.

In the case of Timothy we have an ex- mple of a plant in which self fertilization oes not seem to be accompanied by any decrease in vigour of the inbred progeny. Reference to the Timothy breeding work being carried on at Ottawa will again serve to illustrate my point in this connection. We have on the Central Experimental Farm twenty-six strains of Timothy that are the result of five generations of inbreeding. Most of these strains consistently outyield all commercial mixtures with which they are being tested. A few of the strains also outyield the mixture resulting from combining all the better of the strains under test. This would not be expected to happen if any reduction in vigour, due to inbreeding, occurred. As a consequence the recombining of similar desirable strains of Timothy should not be necessary in securing a profitable improvement over commercial lots.

Between the types of open fertilization represented by Timothy and that represented by sunflowers there are apparently a range of types grading from the former to the latter. The position of each crop in this connection is of prime importance in deciding the policy that it will be necessary to pursue in the improvement of the crop under consideration.

The problems that I have mentioned are only a small part of the sum total of difficulties confronting the Forage Crop breeder in Canada. They are sufficient however, to indicate that, in common with our fellow workers in other countries, we actually have difficulties the overcoming of which will keep us profitably employed through the years to come.

I do not wish to close without emphasizing a need that is, I hope, apparent to most agricultural workers no matter in what country they may be situated. I refer to the desirability of a more far-reaching co-operation than exists at the present time between the world wide workers on agronomic problems. Our agricultural difficulties know no international boundaries and can consequently be solved most advantageously only by international co-operation.

Gratifying advancement has been made in this direction in the past few years but much remains yet to be done before we have reached anything approaching the full possibilities of co-operative effort. May I bespeak for us all therefore a closer co-operation based on a more intimate acquaintance with each other and the special work that each of us is endeavouring to carry to a successful conclusion.

Concerning the C.S.T.A.

BOOTH AND BANQUET AT ROYAL WINTER FAIR

At the suggestion of several members in Ontario and Quebec, it has been decided to rent and furnish a booth at the Royal Winter Fair, Toronto, for the comfort and convenience of C.S.T.A. Members. The booth will occupy a space of 15x10 feet and will be furnished with easy chairs, private telephone, writing desks, stationery etc., so that any members who are in Toronto for the Winter Fair may have a comfortable place in which to meet their friends.

It has also been decided to hold a joint banquet in co-operation with the O. A. C. Alumni Association at the King Edward Hotel, Toronto, on the evening of Thursday, November 20th. Invitations have been sent to the Honourable G. H. Ferguson, Premier of Ontario, Hon. J. S. Martin, Minister of Agriculture for Ontario, Mr. G. I. Christie, Director of the Purdue Experiment Station, Indiana, and Mr. E. M. Carroll, President of the Royal Winter Fair, to give addresses.

Notices of the banquet will be sent early in November to all C.S.T.A. members in Ontario. Members in the other Provinces who contemplate attending the banquet on November 20th, should write to the General Secretary immediately in order that reservations may be made for them.

NOTES

L. S. Klinck (O.A.C. '03) President of the University of British Columbia, recently received an honorary degree of LL.D. from the University of Western Ontario.

J. A. Ruddick, Dominion Dairy & Cold Storage Commissioner has received an honorary degree of LL.D. from Queen's University.

S. J. Chagnon (Iowa State College '21) Assistant to the Dominion Animal Husbandman, is taking postgraduate work at the Iowa State College. He was awarded a scholarship by the C.S.T.A., at the last annual meeting, donated by the Quebec Department of Agriculture.

G. H. Hammond (Macdonald '22) is now attached to the Staff of the Dominion Entomological Laboratory of Hemingford, P.Q.

J. F. Hockey (Macdonald '21) has recently been appointed Pathologist-in-charge of the new Dominion Laboratory at Kentville, N.S.

S. H. Gandier (O.A.C. '11) has been appointed Principal of the Agricultural School at Claresholm, Alta.

G. E. Sanders (O.A.C. '07) has resigned his position as General-Manager of the Doloro Chemical Company in order to establish a new Insecticide Company at Medina, N.Y. He remains as Consultant to the Doloro Chemical Company for the time being but expects to be manufacturing his process dusts at Medina in the near future.

G. J. Spencer (O.A.C. '14) formerly Lecturer in Entomology at the Ontario Agricultural College has been appointed Assistant in Entomology at the University of B.C., in the Department of Zoology.

W. C. McKillican (O.A.C. '05) who has been Superintendent of the Dominion Experimental Farm at Brandon, Man., since 1911, has been appointed Dean of the Faculty of Agriculture at the University of Manitoba. His former position at Brandon has been filled by M. J. Tinline, who was Superintendent of the Experiment Station at Scott, Sask.

R. A. Derick (Macdonald '20) formerly Assistant in Agronomy at the University of British Columbia is now on the staff of the Dominion Experimental Farm at Brandon, Man.

D. C. Schurman (O.A.C. '17) is taking postgraduate work at Macdonald College in Field Husbandry, having been awarded the William C. Macdonald Company Scholarship for Prince Edward Island.

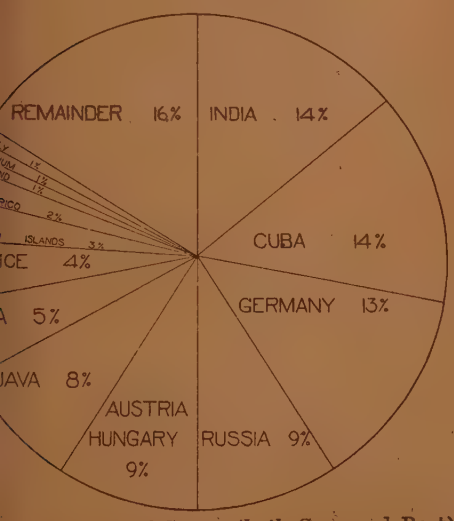
V. Matthews (Macdonald '13) has been appointed Superintendent of the Experiment Station at Scott, Sask. He was formerly Assistant Superintendent at Lethbridge, Alta.

The Sugar Beet Industry.

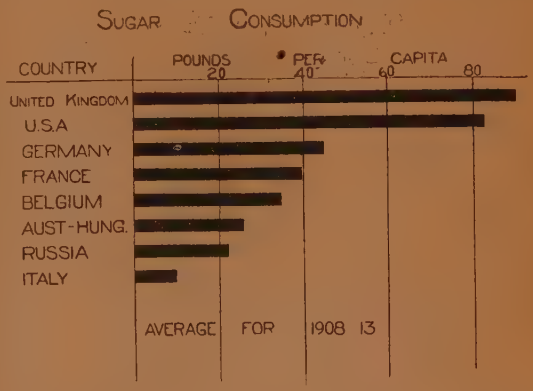
W. F. GEDDES

Manitoba Agricultural College, Winnipeg.

s than 300 years ago the great mass of eople had scarcely tasted sugar, while ne rich it was the rarest of luxuries, and ven esteemed as a medicine. For many the world's supply of refined sugar was ced entirely from the sugar cane, which irst cultivated in India and Egypt, from ce it was gradually carried around the l by the Portuguese and Spaniards. The nt sugar supply of the world is no long- pendent entirely upon the cultivation of gar cane. It was a German professor d Margraf who, in 1774, at Berlin, dis- ed the existence of the same kind of in the root of the beet. The first beet factory in the world was established by rd (one of his pupils) at Cunern, near au, Silesia in 1801. In the meantime roducers of cane sugar had become ed and in 1798 cane sugar interests of- Achard $120,000 if he would aban- is work and make the world believe his pts had not been a success. This offer efused and an attempt was made to des- interest in beet sugar through the cele- d English Chemist Sir Humphrey Davy. ated that while sugar could be obtained from beets, it was too sour for food. The first sugar beet factories experienced many difficulties in purifying the sugar and this together with the low sugar content of the beets discouraged all but the most enthusiastic. The growing of beets for sugar production did not become important until the Napoleonic Wars when commercial restrictions cut off the importation of cane sugar from the West Indies. Napoleon in 1810 offered a prize of a million francs for a practical process for preparing sugar from beets. He was greatly ridiculed for his crazy notion and a cartoonist of the day shows a nurse putting a beet into the mouth of Napoleon's infant son saying, "Suck dear, suck; your father says its sugar". Napoleon established beet sugar schools and set aside large tracts of land to be devoted to sugar beet raising and compelled the peasant farmers to plant sugar beets. The cultivation of the beet for sugar has since spread throughout the countries of Northern Europe and into the United States and Canada, until more than two-fifths of all the sugar of the world, before the beginning of the great war, was the product of the beet. The increase of the world's sugar supply has been rapid ever since sugar began to come into common use. Chart I indicates the rapidity of this increase and the relation of beet sugar production to the total output. The industry was aided on the continent by protective duties and later by the



Production of Sugar (both Cane and Beet)



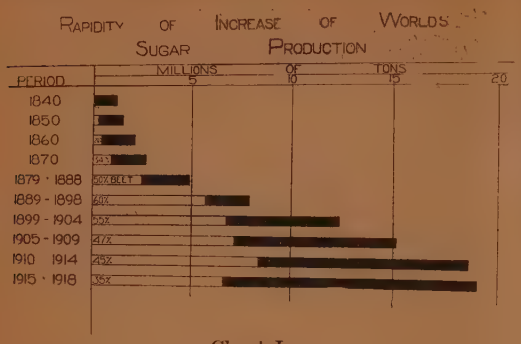


Chart I.

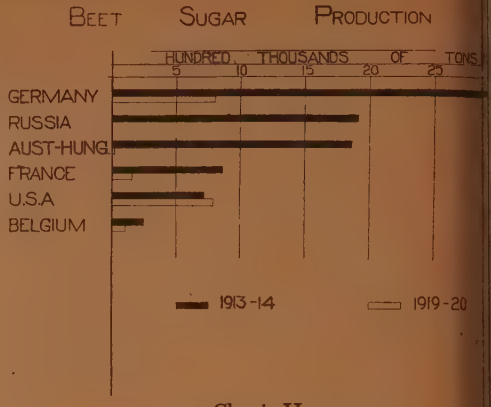


Chart II.

granting of direct or indirect bounties on the exportation of beet sugar. Production responded promptly. In 1840, beet sugar was but 4% of the total sugar production of the world, while in 1890-1899 it constituted three-fifths of the world's total. The result of this bounty system was that beet sugar could be exported by the beet sugar producing countries of the continent at a price which threatened to ruin the cane sugar industry. The situation, after having been considered by various international conferences was finally adjusted by the Brussels International Sugar Convention on September 1st, 1903. The convention included all of the principal countries of Europe, except Russia, which came in on special terms in 1907. The convention was a landmark in sugar history, as it equalized the conditions of competition between beet and cane sugar of various countries by the abolition of indirect, as well as direct bounties on production and exportation of sugar, and a limitation of the rate of import duty. Return to a normal plane of competition, however, did not put an end to the increase in beet sugar production, which was steady until the outbreak of the war; but it did give the cane sugar industry a chance to develop, so that the proport which beet sugar bears to the total has clined. Chart II shows the leading countr in sugar beet production and the decrease European production as a result of war c ditions, while the United States product has expanded.

The first successful sugar beet plant to established in the United States was erec at Alvardo, California, by Dyer, and in 19 there were 98 sugar beet factories and 9 million dollars were paid to growers for be Europe had 1250 factories in operation fore the war. Canada has three success sugar beet factories located at Wallaceb Kitchener and Chatham, Ontario. The crease and value of Canadian production indicated in Chart III.

The sugar beet is a selection of the c mon garden beet and belongs to the bota cal family Chenopodiaceae. It has been proved by plant breeding until a sugar c tent of from 12 to 20% has been obtain The beet root is made up of a series of c

CHART III.

SUGAR BEET PRODUCTION IN CANADA

Year	Acreage	Yield per Acre	Total yield	Average price per ton	Total value	Production of refin beet root suga
	Acres	Tons	Tons	$	$	lbs.
1915	18,000	7.75	141,000	5.50	775,500	39,515,802
1916	15,000	4.75	71,000	6.20	440,000	17,024,377
1917	14,000	8.40	117,600	6.75	793,800	23,376,850
1918	18,000	11.25	204,000	14.61	2,630,027	37,839,271
1919	18,000	9.50	180,000	15.47	5,307,243	89,280,719
1920	34,491	9.94	343,000	12.71	2,593,715	50,092,835
1921	28,367	9.45	268,000	6.50	1,742,000	

c rings of alternating lighter and dark-lor. These rings are composed of two of parenchyma cells; the ones with a dense finer structure being richer in (by an average of 2.6%) and also in matter. Observations have shown that very large beets are low in sugar and nall ones high. Although the sugar beet begins the storage of sugar and other ounds as soon as the first leaves are ed, very little is stored at this time since ood gathered is required for growth. Af-ne sugar beet has produced most of its th and approaches maturity, it stores very rapidly and this storage is not rm in the various parts of the root. The is richest in sugar slightly above the le of the beet and the sugar content de-es towards the two ends. According to nsend, during the period just preceding eet harvest the difference between day night temperatures is apparently one of conditions necessary for the proper ration and storage of sugar and is a ing factor in the production of sugar sufficiently rich in sugar for factory oses. It is probable that the absence of nights at the end of the growing season its the continued growth and develop-of the beets thereby using the sugar in growth instead of storing it.

gar beets in no way constitute a unique They give best returns on a deep fer-oam which is well drained and aerated. y clays or thin stony soils do not per-proper root development. A consider-lime content and an abundance of avail-plant food, especially potash, is neces-A ten ton crop of beets per acre re-s 30 lbs. nitrogen, 14 lbs. phosphoric (P_2O_5) and 70 lbs. potash (K_2O) from oil. A thirty bushel wheat crop removes s. Nitrogen (N), 21 lbs. Phosphoric acid) and 48.8 lbs. potash (K_2O).

attempt will be made here to discuss ral methods, but a great deal of hand is required in thinning the beet plants keeping free from weeds. A recent sur-conducted in a beet sugar area in the ed States to determine the cost of produc-found that 49.5% of the cost was hand r.

When the roots are thoroughly ripe the leaves and crown are cut off by a horse drawn motor, and a machine called a beet lifter is used for pulling the beets from the ground. They are then ready for hauling to the factory.

The various stages in the manufacture of beet sugar involve:

1. Washing the beets.
2. Weighing the beets.
3. Slicing the beets.
4. Extracting the juice by the diffusion process.
5. Straining the juice.
6. Heating the juice.
7. Purification of the juice.
8. Bleaching of the juice.
9. Evaporation to a thick syrup.
10. Crystallization.
11. Curing the sugar.
12. Processes for the recovery of sugar in the molasses.

Washing the Beets: At the factory the beets are stored in bins or piles and flumed into the factory by water from the tail pipes of condensers. The fluming of the beets removes a great deal of the adhering earth and tops. Some water is absorbed by the beet in this process, about 2% being the average amount absorbed. The beets pass over separators to remove rocks or any foreign substance. A wheel removes the beets from the flume and places them in the washer where they are worked toward the farther end by paddles, a continual stream of water flowing through the washer at all times. From the washer the beets pass over a series of rolls, set just far enough apart to keep the beets moving, but allowing any small pieces or tailings to drop through.

Weighing the Beets: From the rolls the beets are discharged into an elevator which carries than to an automatic weighing machine at the top of the factory.

Slicing the Beets: The weighing machine empties the beets into a hopper which feeds them directly into the slicing machine. Here the beets are cut into V shaped slices called cossettes. Cutting in this manner exposes the greatest amount of the cell structure of the beet to the action of the sugar extracting medium, and at the same time permits circulation between the slices.

Extracting the juice by the Diffusion Process: The cossettes pass from the knives to the cells of the diffusion battery.

The diffusion battery consists of a number of cylindrical iron vessels, usually 14, with suitable pipe connections, heating devices and top and bottom doors. The pipes are so arranged that the liquid may be conducted from the vessel to the next, entering at the top or the bottom, at the will of the operator, and permitting any vessel to be disconnected from the series for charging with slices and discharging the spent pulp. The batteries are so arranged that the container which has had its charge for the longest time receives the fresh water, which removes the last traces of sugar that can be extracted, then travels from one cell to another absorbing from the cossettes more sugar until it arrives at the next recently filled cell. The sugar content of these cossettes being higher, the water becomes more heavily saturated with sugar and a portion of the juice is drawn off from the last cell filled. The control of the battery temperatures is of the highest importance. The slices must not be overheated or they will matt and impede the circulation of the juice. If the temperature is too high the cell membranes of the beets break down, and the pectic bodies pass into solution in the juice and thus a more impure juice is obtained making subsequent processes more difficult.

The diffusion process depends in theory on the property possessed by crystalloids of passing from one solution into a contiguous solution through a semi permeable membrane that separates the two liquids. This action is termed osmosis or dialysis. Under the same conditions colloids pass through the membrane, but slowly, if at all. The crystalloids of the beet, of which sugar is the principal one, include most of the mineral salts, and salts of the organic acids, and albumins are among the colloid bodies. In the application of osmosis, in the extraction of sugar from the beet, the walls of the plant cells themselves supply the membranes. However, in slicing the beets, many of the plant cells are ruptured and the process is really one of osmosis and maceration. Sharp knives are always used in slicing the beets in order to avoid rupturing more cells than is necessary. The temperature of the water used fo dialysis varies with the quality of the but a temperature from 80 - 84°C. u gives good results.

The volume of juice to be drawn fron diffuser must be carefully controlled. little is drawn the extraction of the su imperfect and too much unnecessarily d the juice, causing waste of fuel. Under ful control about .3% of the sugar of th remains in the pulp and water. The p forced from the cells, and may be silo desiccated in a continuous dryer and s The dry pulp is 5 to 6% of the weight beets.

Straining the juice: The beet after being drawn from the diffusion b always contains very fine pulp that pass strainers of the diffusion battery. This is largely removed by special strainers c depulpers.

Heating the raw juice: The raw diffusion juice from the beets varies in tity from 125 to 160% on the weight o beets and contains 11.5 to 13% sugar a purity of 82 to 85%. The raw juice afte pulping has a temperature of 40 to 50°C the best temperature for carbonation is 8 The juice is consequently heated to a 90°C. and part of the albuminous m present is thus coagulated.

Purification of the juice: The fication of the heated raw juice is bro about in tanks known as carbonators. purification is accomplished by the additio milk of lime, and in a factory using the fen's process of recovery of sugar from waste molasses, the tricalcium saccha formed is added to the raw juice at this s The addition of the lime causes the preci tion of the organic acids and their salts (w were extracted from the beets along with sugar) as the calcium salts. The lime renders the juice alkaline, which is a ne sary factor to prevent the sugar from br ing down into glucose and fructose, du the further process of heating and evap tion. The amount of quicklime used eq about 4.5 per cent of the weight of the b worked. After liming, carbon dioxide forced into the tanks which precipitates excess of lime as $CaCo_3$ and the precipi occludes and carries down much of the

ing organic impurity. Carbon dioxide ssed until the alkalinity is reduced to 1 calcium oxide per litre of juice. The n dioxide used in this step is obtained the lime kilns in which the limestone is ed.

rbonation Presses: The carbonated is now filtered through squares of can- eld on iron frames. The lime and in- le substances are left on the canvas in rm of a cake. This is removed and may rned again to form quick lime or washed a tank from whence it is removed and with irrigation water on the land.

the conclusion of the carbonation the is heated almost to its boiling point, pressed and transferred to the second nation tanks. The juice usually still ins considerable lime and carbon diox- again passed at a temperature of nearly C. until the juice contains only .25 to .3 calcium oxide per litre. The reduction e lime content of the juice is very im- nt since a high lime content will cause vaporation to be sluggish in the vacuum After this second carbonation the juice ain filtered on canvas filters and more cake is produced. The juice is now of a straw colour and is known as second nation juice.

eaching the juice: The addition of Sul- dioxide is generally the next step which er reduces the alkalinity and bleaches the After sulphuring the juice is again d to the boiling point and filtered.

aporation of the juice: The juice is ready for evaporation, which is carried nder vacuum in multiple effect evapora- The juice enters the evaporator at a ty of about 14° Brix. and leaves at about Brix. Due to evaporation the alkalinity metimes so greatly increased that a se- sulphuring is necessary in order to re- it. The filtering is done by adding lguhr which acts as a filtering medium e filter presses.

aining: The resulting light colored is now ready for graining. This is ac- lished in vacuum pans by evaporating hick syrup until crystals of sugar form, which more syrup is added and evapor- continued successively until the opera- tor has finished the pan or strike. Sometimes sugar powder is added to the saturated solution, thus obtaining a more uniform grain.

Massecuite Centrifuged: The grained syrup is then centrifuged and the crystals remaining are washed free from adhering molasses which is called green syrup. The molasses separated from the sugar by the centrifugal machine is concentrated again in the vacuum pan, whereby again, a crystalline mass is formed. This sugar is slightly yellow, and is dissolved, filtered and added to the syrup from which the white sugar is boiled. The remaining syrup from this yellow sugar is the molasses, and constitutes 3 to 5 percent of the original weight of the beets.

Drying, curing and packing: The sugar from the centrifugals contains 2.5 to 3.5 per cent moisture and is fed into the granulator or dryer through which a current of hot air is drawn. The sugar is dropped from shelves and in falling on to a rotating drum, the crystals are separated and dried. The revolving drum is inclined to the discharge end where the sugar is classified by sieves and delivered to the packing spouts.

Disposal of the Molasses: The presence of impurities in the liquor prevents the complete crystallization of the sugar and ordinarily 16 to 19 per cent of the total sugar of the beets remains in the molasses. The molasses has a coefficient of approximately 60 percent. and contains 50 per cent sugar. The molasses from the sugar beet is too bitter to use as human food, but in many factories it is sold for stock feeding purposes, or for the manufacture of alcohol, but at the present time several factories are using procedures for the extraction of the sugar from the molasses. The most important process in common use in America is the Steffen's process. The principle of this process is to precipitate the sugar of the molasses by the addition of freshly burned quick lime of high purity. This is carried at a temperature below 15° Centigrade and refrigerating apparatus is essential. The molasses is diluted to a sugar content of six per cent, cooled, and small measured quantities of lime are dusted in. The insoluble lime sugar compound which precipitates is filtered out and mixed with water to form a cream. This cream is used

for liming the raw juice previous to carbonation. Upon treatment with carbon dioxide the lime sugar compound is decomposed, limestone is precipitated and the sugar is liberated. By good Steffen's operation it is possible to recover from 92 to 95 per cent. of the sugar originally present in the molasses.

Requirements for the Success of a Beet Sugar Factory and the Possibilities in Manitoba.

The establishment of a beet sugar industry in Manitoba would be of great importance to the agricultural industry of the province which needs stimulation of more intensive methods. Experience has shown that wherever a beet sugar factory has been established the price of farm land has risen because the raising of beets promotes better farming and results in a higher return per acre, the deep plowing and thorough tillage so indispensable to beet culture increasing the yield of subsequent crops on the same land. Experiments in Colorado have shown that when sown on land following beets the following increases in yield were obtained: Wheat 24 per cent, Barley 25 per cent, Oats 42 per cent, Potatoes 102 per cent. Beets make an excellent crop to fit into a rotation since the tillage they require eradicates weeds, and, being deep-rooted, they bring from a con erable depth plant food which is later m available to shallow rooted plants.

Although there are obvious advantages agriculture in the growing of sugar beets, it must be remembered that a sugar fact constitutes a very large investment. Ex ience in the United States has indicated tain requirements for success.

The first and most obvious requirement a sufficient supply of beets of high qual The beets must be high not only in su content but also purity coefficient. In b of low purity coefficient the large percent of non sugar solids of the juice prevents crystallization of some of the sugar in process of evaporation and renders the ext tion of this sugar impossible except by Steffen's or other recovery processes wh greatly increase the cost of manufact The yield and quality of sugar beets gro in Manitoba has been under investigation some years and the following results are ported by years:—

Summarized Report of Sugar Beet Investigations.

1. 1917.

During the summer of 1917 experime on the growing of sugar beets were condu

ANALYSIS OF SUGAR BEETS GROWN UNDER DIRECTION OF FIELD HUSBANDR DEPARTMENT, MANITOBA AGRICULTURAL COLLEGE AND DEPARTMENT OF AGRICULTURE.

Name of Grower	Locality	Date of Seeding	Date of Harvesting	% of Sugar in juice	% coefficien of purity of juice
David Brown	Deloraine	May 21	Oct. 17	14.7	72.4
N. S. Gerrard	Virden	May 28	Oct. 15	14.8	72.2
J. B. Thickens	Ashern	May 3	Oct. 6	10.0	71.4
R. E. Heise	Isabella	June 1	Sept. 27	11.10	53.7
W. C. Coltart	Melbourne	May 28	Oct. 8	11.9	71.7
H. C. Langrell	Woodlands	May 26	Oct. 12	19.5	80.0
J. Tolton	Oak Lake	June 4	Oct. 24	19.8	68.3
Field Husbandry Dept.	M.A.C.	May 17	Oct. 9	17.0	85.3
J. G. Wiederhold	Mun. of Rockwood	No record		11.3	70.1
D. W. McIntyre	"	"		10.7	70.0
H. H. Wieneke	"	"		15.0	77.7
Geo. Laing	"	"		11.6	72.0
Jas. Palfer	"	"		15.1	83.0
Wm. Bennet	"	"		16.3	82.3
Wm. Hand	"	"		15.0	80.0
F. H. Wieneke	"	"		13.4	87.0
Greater Wpg. Water Dist	"	"		12.5	81.1

various parts of the Province under the tion of the Field Husbandry Depart- of the Manitoba Agricultural College. ddition to this, the Department of Agri- re distributed seed to farmers in several icts. The seed distributed in both cases of the Klein Wanzleben variety.

ter harvesting samples were forwarded e Chemistry Department for analysis. In cases the samples received were badly d and were unfit for chemical analysis. e were discarded and the accompanying shows the results obtained from the les judged fit for analysis. (Page 106).

of Seeding Experiment, Field Husbandry Department, Manitoba Agricultural College

date of seeding experiment was also con- d during 1917. This experiment was ed out in duplicate on land which was ously fall plowed and manured at the of ten tons rotted barnyard manure per The seeds were planted on the level ws thirty inches apart. Four dates of ng were used and the results secured are in the table below. The variety of seed was Klein Wanzleben.

ARKS:

reference to the adjoining tables a wide in sugar content and in purity is noted. ie average the percentage purity is low. may be due to the relatively high per- ge of soluble salts in the soil and also e immaturity of the beets. The results ie Dates of Seeding Experiment, how- would indicate that the coefficient of y was largely dependent upon the stage aturity.

reporting these results the late Profes- . J. Galbraith called attention to the fact he quality of the beets was below the ge. He reported in part as follows:

"The results of the experiments show that the quality of beets is below the average. This has been the experience of the Federal Department of Agriculture with respect to the beets grown on the Experimental Farm at Brandon, the reason given by Dr. Shutt being—"The excessive growth made in the early months of the summer and the immaturity of the roots owing to the cool autumns which frequently obtain."

"We do not consider that there is sufficient evidence, however, to prove that the beets grown in the Province are below average in sugar content and in purity, and would, therefore, advise that further experiments be conducted over a period of years, that the method of cultivation be standardized, that the plots be inspected regularly and notes taken throughout the growing season, and that samples for analysis be taken and yields per acre be determined by inspectors appointed for that purpose."

1920.

No chemical analyses of sugar beets were made during the years 1918 and 1919 due to the death of Professor Galbraith, and changes in the staff of the Chemistry Department. Sugar beets were grown in an experimental way, however, during these years by the Field Husbandry Department, and a table will be presented showing the yields obtained.

During the year 1920 Mr. C. J. McCollom, a Winnipeg business man, became interested in the growing of sugar beets for factory purposes. Mr. McCollom distributed imported seed, (said to be of the Klein Wanzleben variety) to reliable farmers in the vicinity of Winnipeg. In the autumn samples from these plots were sent to the Chemistry Department of the Manitoba Agricultural College, the Wisconsin Sugar Company, Menemonee, Wis., The Iowa Valley Sugar Company, Belmond, Iowa, and the Minnesota Sugar Company, Hutchinson, Minn., for chemical analyses.

DATES OF SEEDING EXPERIMENT.

sown	Date Harvested	% sugar in juice	% coefficient of purity of juice	Yield per Acre Tons	Pounds
19	Oct. 10	17.0	85.8	8	1820
30	" "	14.3	70.4	9	1668
15	" "	15.4	74.5	13	532
7	" "	14.5	69.4	3	996

	Chemistry Department M. A. C.		Wisconsin Sugar Company		Minnesota Sugar Company		Iowa Sugar Company	
	Per cent of Sugar in juice	Per cent coefficient of purity of juice	Per cent of Sugar in Beet	Per cent coefficient of purity of juice	Per cent of Sugar in Beet	Per cent coefficient of purity of juice	Per cent of Sugar in Beet	Per cent coefficient of purity of juice
1.	19.4	81.0	16.4	Purity of composite sample = 84.1	14.0	73.2	11.9	73.4
2.	19.4	74.1	15.0		14.8	70.4	15.0	74.8
3.	15.4	72.8	1.8		13.2	71.1	12.7	72.8
4.	20.1	74.3	19.8		19.0	70.4	12.2	—
5.	21.4	74.1	18.4		18.6	73.2	17.6	—
6.	17.4	77.9	19.8		18.5	73.2	19.1	—
7.	19.8	85.4						

The analytical reports of these different laboratories are summarized in the above table: (note that the Chemistry Department, M. A. C., reports the percentage of sugar in the juice, while the other laboratories report percentage of sugar in the beet).

REMARKS:

It will be noticed that there is considerable variation in the percentage of sugar and the purity reported by the different analysts. This variation is no doubt due to the variation in the samples sent for analysis, and also to the condition of the samples when analyzed, in some cases the beets being badly shrivelled when received. (The Wisconsin Sugar Company report that the samples were so wilted that they could not secure sufficient juice to make a purity determination on each sample, and could only make this determination on a composite sample of juice).

All analysts reported a low percentage of purity, with the exception of the Wisconsin Sugar Company. The Minnesota Sugar Company in their letter reporting their results, in calling attention to the low purity, state that with beets having a sugar content of 19% and a purity of 70% as far as extraction in the factory was concerned, this would be equivalent to a beet containing 10 per cent. sugar.

In addition to the analyses made for Mr McCollom several analyses were made o sugar beets grown in the experimental plot at the College farm. Samples were taken a weekly intervals, commencing on Septembe 13th, until the beets were harvested, from plot of beets seeded on May 31st. The result obtained are tabulated at bottom of page.

These results also indicate that maturity i an important factor in purity.

1921.

During the year of 1921 the Chemistry staf was engaged in soil analysis and only on sample of beets was analyzed, with the fol lowing results:

Location where Grown	% Sugar in juice	% Purity in juice
Portage La Prairie	15.7	77.2

SUGAR BEET ANALYSES, 1922

In the spring of 1922 Mr. McCollom dis tributed imported seed to farmers located a points within twenty-five miles of Winnipeg Two beets from each point were submitted to the Chemistry Department and samples from the same plots were sent to the Spreckels Sugar Company in San Francisco. According to information submitted with the samples the seed was not planted until late in May, due to a delay in receiving and distributing the seed to the growers. The 1922 season was

Seed Planted	Sample Analysed	Sugar in Juice	Per cent coefficient of purity of juice.
May 31	Sept. 18	11.6	68.5
" 31	" 21	12.0	74.4
" 31	" 27	13.2	68.1
" 31	Oct. 4	11.70	70.0
" 31	" 11	14.00	77.3
" 31	Beets lifted " 12	14.00	80.5
" 31	(After beets lifted one week)	14.20	78.1

2. CHEMISTRY DEPARTMENT Spreckels Company San Francisco.

ality where grown	Per cent of Sugar in juire	Per cent coefficient of purity of juice	Per cent of sugar in beet	Per cent coefficient of purite of juice
ny Mountain	16.3	76.2	14.0	74.0
rquette	14.9	72.7	12.3	70.2
n. Agricultural College	14.5	74.7	15.0	81.5
gyle	17.7	80.4	15.0	77.2
kport	17.0	73.9	14.2	68.7
st Selkirk	16.4	81.2	14.9	88.8

particularly favorable for sugar beet pro-ion as the precipitation was quite high, mpanied by cool weather during the ving months.

he analytical results obtained by this de-ment and the Spreckles Company Lab-ory are tabulated above.

he San Francisco Laboratory of the eckels Company reported disappointment he yield of the samples submitted, stating ever, that the beets as received for analy-were more or less decomposed, being quite ldy. The San Francisco interests stated that probably the seed used was not of the best quality and offered to supply seed of their own growing for another year.

1923.

In the spring of 1923 Mr. McCollom distributed seed supplied by the Spreckels Sugar Company, San Francisco (said to be seed grown locally from selected beets) to several Manitoba farmers. Samples from these plots were submitted to the Chemistry Department, Manitoba Agricultural College for analysis and also in many cases to the Northern Sugar Corporation, Mason City, Iowa. The analytical results obtained are tabulated below.

ANALYSES—BEETS 1923 GROWN FROM SEED SUPPLIED BY SPRECKLES SUGAR COMPANY

		CHEMISTRY DEPT. M.A.C.		NOR. SUGAR COMPANY Mason City, Iowa.
ne of Grower	Location	Per cent of Suggar in juice	Per cent of purity of juice	Per cent of Sugar in Beet
n. Agric. College	Winnipeg	18.2	89.7	15.5
Zubroniowicz	Elma	23.0	90.8	17.2
me for Incurables	P. La Prairie	19.2	82.9	16.8
H. Young	Oak Bluff	15.6	80.6	14.9
Brown	Rosenfeld	19.0	81.1	16.2
S. Rempel	Chortitz	16.6	78.9	16.4
Trychnicwiz	G. W. W. D.	19.0	84.5	13.6
R. Pawliske	Dauphin			13.2
B. Andre	La Broquarie	15.6	84.0	15.8
M. Sivovanz	Libou	22.6	85.3	19.7
Cox	Lakeland	18.4	87.1	17.4
C. Kosabaski	G. W. W. D.	19.0	85.2	18.2
W. Cremann	Edwin	22.7	90.2	15.7
Bryan	Badger	14.6	67.4	18.5
Witowitz	Gimli	20.0	89.3	17.0
me of Incurables	P. La Prairie	19.4	74.5	16.4
Neiser	Beausejour	19.2	84.0	17.1
Marcoux	Lorette	18.6	81.4	
F. Kroelgel	R.R. 4, Winnipeg	19.8	82.9	
. Dean	" " "	26.4	93.2	
Richardson & Son	St. Norbert	16.8	83.3	
F. Chorette	La Rochelle	19.0	78.1	
A. Nault	" "	21.1	81.7	
E. Cotellier	" "	20.2	79.8	
	ANALYSIS OF BEETS FROM MINNESOTA			
. McCann	Thief River Falls	21.4	91.7	
"	" " "	22.8	89.9	

Remarks:

The beets grown in 1923 show a much higher purity than those grown in any previous year and the average sugar content is also very satisfactory. The growing season of 1923 was particularly favorable for the production of mature beets as there was relatively little precipitation during the growing season with the result that rank vegetative growth did not ensue and more mature beets were produced. The favorable quality of the beets produced in 1923 may have also been due, at least in part, to the seed used, but further work carried on in future seasons would be necessary to determine the influence of the seed.

Sugar beets for factory purposes are grown as far north in Minnesota as Thief River Falls, and an analysis of two samples from this location shows a very favorable sugar content and purity coefficient.

Average Yield per Acre.

Sugar beets have been grown on the College farm for a number of years in an experimental way. The variety used until the year 1919 was Klein Wanzleben, but since that year the beets were grown from seed supplied by C. H. McCollom.

The yield per acre is expressed as the total weight of roots at the time of harvesting. (The roots were not topped at the sun line).

Year	Date of Seeding	Tons	lbs.
1915	May 10	11	1350
1916	June 13	5	422
1917	May 17	16	582
1919	May 21 (Reseeded June 18)	18	1390
1920	May 31	15	1680
1923	June 2	14	821
	Average	12	1707

SUMMARY:

From the results reported here it is apparent that satisfactory tonnage can be grown per acre, but until 1923 beets of low purity were produced. Whether the high purity obtained in 1923 is the result of improved seed or the favorable climatic conditions which prevailed during the growing season is a question we cannot answer until further experimental work is carried on.

Essential Conditions for Successfu Beet Culture.

F. S. Harris in his book entitled "The Su ar Beet in America" outlines very clear some of the essential conditions for growin sugar beets for factory purposes. In discus ing climatic conditions he states in par "The sugar beet will grow in most parts c the United States and Canada where the ordi ary crops of the temperate climate thrive but the region maturing beets of desirab sugar content, purity and yield is confine to a rather narrow strip across the continen It lies largely in a wedge shaped area in cluding California, Oregon, and Washingto on the West, and tapering irregularly to th East, with Michigan and the States to th East as the sharp end of the wedge."

"So far as sugar is concerned, the be sugar beet regions are those with an averag temperature of about 70°F. during the thre summer months, June, July, and August A great amount of heat is not required whe the beets are young; neither will they thriv if the weather is cold and damp just afte planting. This condition retards germina tion and causes part of the seeds to deca in the soil. The young plants that emerg are also likely to be attacked by disease, suc as that caused by the damping off fungi. Wit a protracted cold spring, the young beet sometimes receive a set back from which the never fully recover."

"A severe frost just as the plants are com ing up is almost fatal and replanting is usual ly necessary. Severe freezing in the fal is likely to cause trouble by freezing th beets in the ground, in which case it is very difficult and sometimes impossible to harves them and almost complete loss results." In order to be entirely safe, an area raising sugar beets should have about five months in which severe freezing does not occur. Sligh frosts during this time, particularly in the fall may do no damage. The short season in the cooler parts of America prevents the proper ripening of the beets, resulting in a low sugar content and consequently poor milling quality.

First let us consider the question of tem perature. Harris has said that an average temperature of 70°F. is essential for successful sugar beet industry. The following table gives the average monthly temperature in Manitoba for June, July and August since 1915.

AVERAGE TEMPERATURES IN DEGREES FAHRENHEIT AT MANITOBA AGRICULTURAL COLLEGE, WINNIPEG.

(Supplied by Physics Dept., M.A.C.)

Year	June	July	August
1915	55.9	61.8	63.9
1916	57.8	70.9	63.4
1917	56.7	68.1	61.2
1918	58.5	61.2	63.1
1919	66.6	67.8	64.4
1920	61.9	65.7	68.7
1921	66.4	70.1	63.1
1922	63.9	64.4	66.8
1923	67.3	70.4	60.3
Average 1915-1923	61.66	66.7	63.88

AVERAGE TEMPERATURE IN DEGREES FAHRENHEIT AT KITCHENER, ONT.

(Abstracted from Dominion Weather Bulletin.)

Year	June	July	August
1915	60.2	66.2	64.0
1916	59.0	75.0	70.0
1917	59.0	69.0	65.0
1918	61.0	68.0	72.0
1919	71.0	72.0	67.0
1920	63.0	64.0	66.0
1921	66.0	75.0	64.0
1922	65.0	67.0	66.0
Average 1915-1922	63.00	69.5	66.75

Sugar beets, however, have been grown successfully in Canada for the Dominion Sugar Company, and the adjoining table gives the average temperatures at Kitchener, Ontario, where a factory is located.

The temperature conditions as outlined by Harris are not met either at Kitchener, where beets for factory purposes are successfully grown, or at Winnipeg, but the average temperatures for Winnipeg are considerably lower than at Kitchener, Ontario.

The following figures compiled by the Physics Department, M.A.C. show the average temperatures for June, July and August for the number of years that figures are available.

AVERAGE TEMPERATURE FOR JUNE, JULY AND AUGUST FOR MANITOBA POINTS.

Location	Temperature in Degrees Fahrenheit	Number of Years Considered in average
Winnipeg	63.34	46
Portage La Prairie	63.26	26
Oak Bank	61.72	20
Souris	63.33	9
Russel	59.76	21

The table below, compiled by Prof. S. C. Lee, of the Physics Department shows the average frost free period for several Manitoba points.

AVERAGE FROST FREE PERIOD AT DIFFERENT MANITOBA POINTS.

Location	Frost Free Days	Frost Free Period	No. of years considered in securing average
Birtle	80	June 10 to Aug. 28	12
Boissevain	116	May 24 " Sept. 16	3
Brandon	82	June 8 " Aug. 28	29
Carberry	67	June 16 " Aug. 21	4
Dauphin	102	June 3 " Sept. 12	15
Elkhorn	93	June 6 " Sept. 8	4
Goodlands	95	June 9 " Sept. 11	2
Hamiota	47	June 12 " July 28	5
Minnedosa	81	June 8 " Aug. 27	38
Morden	110	May 31 " Sept. 17	16
Morris	97	June 7 " Sept. 11	4
Ninette	91	May 31 " Aug. 29	9
Portage La Prairie	110	May 29 " Sept. 15	27
Rockwood	101	May 31 " Sept. 10	5
Russel	71	June 11 " Aug. 20	21
Souris	107	May 29 " Sept. 12	8
Swan River	79	June 13 " Aug. 30	10
Treherne	93	June 6 " Sept. 6	26
Virden	86	June 7 " Aug. 31	17
Winnipeg	100	June 1 " Sept. 8	46

The frost free period in Manitoba is of relatively short duration but the period between killing frosts would be somewhat longer. The writer feels however, that Manitoba would fall considerably short of a five months period free from killing frosts and that this climatic factor is deserving of very important consideration. Severe freezing in the early fall would in some years render harvesting of the beets difficult or impossible and result in a total loss.

In addition to a satisfactory temperature, favorable soil moisture conditions are very essential to successful beet culture. A region having the greater part of its rainfall during the growing season is very favorable. The extent of rainfall at any given time is very important, as in a district having heavy soil that packs or crusts, a heavy rain at the time the plants are sprouting may be the cause of trouble while small showers often do not wet the soil deeply enough to be of much value.

Wind is also a climatic factor to be considered. Spring winds that come during the planting season are sometimes serious. The seed may be blown out of the ground and make the stand very irregular, and the seedlings may be injured by the cutting action of the fine soil particles.

In addition to favorable climatic conditions, economic conditions must be taken into consideration. In this regard Harris says: "Sugar beets have not secured a strong foothold in the great wheat sections of the country, partly because the farmers can earn more money with less labour by handling a large acreage of wheat than by handling a few acres of beets. The farmer who has been used to raising 500 to 1000 acres of wheat and doing most of the work by machinery is not likely to be satisfied to spend all of his time over 15 or 20 acres of beets, particularly if he has to do most of the work by hand. More than ten times as much labour is required to raise one acre of beets as to rai one acre of wheat, over five times as mu as to raise an acre of corn, and more th twice as much as to raise one acre of pot toes."

"Successful sugar beet growing requir good farmers. Every operation from t plowing of the land to the delivering of t beets is particular and calls for painstakin care. There is no operation that can slighted without reflecting itself in the r turns. Many farmers fail because they a not willing to look after details. They wa to apply wheat growing methods, and tho methods simply will not succeed with sug beets."

"In considering the advisability of esta lishing a factory in a region considerable a tention should be given to the kind of far ers who will raise the beets."

With regard to the factory itself America experience has shown that to be financial successful a factory must handle at least 5(tons of beets daily and have an average ru of 100 days each year. With an average yie of 10 tons beets per acre five thousand acr of beets per year would be required, or i order to provide for proper crop rotatio 15000 acres of good beet land would be e sential. The factory requires an abundan supply of pure water as large quantities o alkali salts in the water make the extractio and purification of the juices much mo difficult.

In conclusion it is evident that many fa tors enter into the success of a sugar bee factory such as soil conditions, the type o farmers, transportation costs, cheap labou and many other factors too numerous t mention. The writer does not consider tha the experimental results so far obtaine would warrant the establishment of a suga beet factory in Manitoba with the large cap tal expenditure involved.

Aberrant Forms in Arctic Sweet Clover.

LAWRENCE E. KIRK

Professor of Field Husbandry, University of Saskatchewan, Saskatoon.

This year some peculiar plants which are viously of sweet clover parentage, were ob- ved in our increase field of Arctic sweet ver. These proved to be so exceptional t a thorough search was made in an eight re field and altogether 10 very distinct ms were discovered. It was thought that se might be of sufficient interest to warrant orting here. More than one plant was se- red from most of the forms and ripe seed tained from several. Each form was giv- a number and photographed. Nos. 2 to and No. 10 are reproduced in plates I, II d III. Arctic is included for comparison. These are comparable as to size. Figure I shows the flowering parts in greater detail. Fig. II shows the character of the foliage and the branching peculiar to some of the forms. Fig. III shows the well developed and much branched crown of Form No. 1.

The explanation for the occurrence of these peculiar forms is problematical. The wide difference between plants of different forms and the number of characters involved seem to preclude the idea of mutations. The most plausible explanation would seem to be that they are natural hybrids, alfalfa probably being the other parent. While they

FIGURE I.

Flowering parts of aberrant forms in Arctic sweet clover. The numbers correspond to the numbers under which each of the forms are described in the text.

A.—Podded racemes of typical Arctic.

H.—Undescribed forms which resemble Form No. 4 at the tips of the branches and Form No. 7 in other characters.

5.—Two types of the same form.

FIGURE II.

Stems and foliage characters of aberrant forms in Arctic sweet clover. The numbers correspond to the numbers under which each of the forms are described in the text.

O.—An undescribed form similar to Form No. 7 but with tufted foliage.

FIGURE III.

This shows the well developed and much branched crown of Form No. 1.

have little resemblance to alfalfa they approach it in certain characters, such as the branching crown, numerous stems, elongated slightly coiled pods, foliage, and constricted flower clusters. It is significant that our Arctic sweet clover in 1921 was grown in an isolated long narrow field adjacent and parallel to a field of Grimm alfalfa. These are the clues which lend weight to the theory of an alfalfa sweet clover parentage.

A brief description of the various forms may prove interesting. Normal Arctic this season in the same field is about four feet tall and heavily seeded. It was almost ready to cut when the aberrant forms were observed.

Form No. 1 is three feet tall. Numerous fine stems 30 to 40 in number are produced from a well developed crown which branches and rebranches like alfalfa. The plants were observed when mature which may account for the absence of foliage. The pods and racemes are normal. There were three plants of this form from all of which an abundance of seed was secured.

Form No. 2 is similar in all respects to Form No. 1 except that it is very leafy. The plants, three in number, were first observed when just beginning to ripen. Considerable seed was secured.

Form No. 3 has four primary stems from crown buds, three feet high, with strong branching habit from root to top. The racemes are weak and about three quarters of the usual length bearing white flowers on pedicels elongated to three times the normal length. About three quarters of the flowers produce long narrow, slightly coiled pods ⅜ to ¼ of an inch in length. The flowers are abnormal in that the wings and keel are the same length as the standard and cupshaped, with stamens and pistil exposed. The pods are exserted well beyond the petals before the latter wither. They contain from one to three embryo seeds which never develop, the pods withering after becoming fully grown. One of the four primary stalks produced normal sweet clover pods on all of its racemes. (See Plate I) Only one plant of this kind was found. A few ripe seeds were secured.

Form No. 4 has four coarse stems from crown buds, each of which produce numerous

but very short branches. The entire plant has a constricted tufted appearance. The secondary branches are from ¼ to 1 inch in length and on these all of the leaves and flowers of the plant are produced. The miniature trifoliate leaves are so close together that they appear bunched and in the axils of each are tiny undeveloped buds attached to extremely short flowering stalks. Only in a very few cases were petals visible. The plant is strictly sterile.

Form No. 5 resembles nothing so much as lambs quarter. In respect to root, stems, branches and leafage, it resembles a typical plant of Arctic sweet clover. The racemes, however, which are of normal length are best pictured by reference to plate IV. At irregular intervals on the rachis of the raceme clusters of buds are produced on very short pedicels. Each pedicel may again rebranch, thus forming several clusters in a group. The buds are exceedingly small and the whole cluster may be so much constricted that half a dozen of them are smaller than a normal sweet clover pod. Three plants of this form were found, all of which were sterile.

PLATE I.

Aberrant forms in Arctic sweet clover. The numbers correspond to the numbers under which each of the forms are described in the text.

PLATE II.

Aberrant forms in Arctic sweet clover. The numbers correspond to the numbers under which each of the forms are described in the text.

PLATE III.

Aberrant forms in Arctic sweet clover. The numbers correspond to the numbers under which each of the forms are described in the text.
A.—A typical Arctic sweet clover plant from the same field as the aberrant forms.

Form No. 6 has about six primary stems one of which is fully podded; another produces small slightly coiled abortive pods similar to those described for Form 3; the rest have pods of both types on the same branch. The pods on the branch that is producing seed are nearly all well developed but they differ from normal sweet clover in that the pedicel is longer and the pods stick out at right angles to the stem on which they are borne. The pods are also slightly different in shape. Two plants of this form were found and a few seed secured.

Form No. 7 is about five feet in height. There are four main stems of normal size, which are much branched. The stems and branches become abnormally fine about 18 inches from the ground and grow more attenuated toward the top, giving the plant a somewhat vine-like appearance. This appearance is accentuated by the very numerous rather long rachises from which the abortive flowers fall, soon after they appear. The plant is almost sterile but here and there are fully developed well filled pods averaging about one for each raceme. There are some half dozen plants that may be classified as belonging to this form, although the differences between them are quite conspicuous. A few seeds were secured.

Form No. 8 is four feet in height but otherwise much reduced in size. The few short branches produce small elongated leaves, which resemble those of alfalfa, in clusters which are almost sessile. There are no flowers. Two plants of this form were found differing from one another in colour and shape of leaf.

Form No. 9 is like sweet clover in most respects except that the flowers are produced on weak racemes and are mostly abortive. This form, of which we found five plants is almost sterile but some ripe seed was secured from two or three of them.

Form No. 10 has a short bushy habit of growth. It has a very peculiar inflorescense in that the flower clusters resemble those described for Form No. 5, and are produced on branches growing out from what would normally be the rachis of the raceme. This branched inflorescence is pyramidal in shape and feathery in appearance. This is the only form having this character. Only one plant of this kind was found and it was sterile.

The Effect of Certain Methods of Handling Clean Cream on Its Grade.

NORMAN JAMES

Manitoba Agricultural College, Winnipeg.

Cream grading has become established as recognized part of the routine of every reamery in Western Canada. It serves as a air basis for making returns to the producer -one founded on the well known truth that ood butter can be made only if good cream s used. Furthermore, the extra reward for igh quality furnishes the stimulus for spec-l effort and the ultimate result will be not nly better immediate returns to the pro-ucer, but an industry based on a sound per-anency that will ensure prosperity to the ountry that fosters it.

That there must be an ever watchful eye n the quality of our butter is evident from ne fact that there is,—and must be in a ountry so essentially agricultural—an ever ncreasing overproduction of butter, creating surplus which finds itself on the open mar-et in competition with that produced in ountries whose climatic conditions and the atural inclination of whose peoples are more avorable to a specialization in dairying. In 923 alone more than one and one-quarter illions of dollars' worth of butter were hipped out of Manitoba, some to eastern entres but a large portion to the British Isles nd United States—the total export trade rom the Dominion being valued at $8,243,138.

A study of the grade percentages of cream raded in the Manitoba creameries under the upervision of the Provincial Government epartment of Agriculture, Dairy Branch, eveals the fact that in 1923, the first year hat a uniform grading service was in opera-on 1,732,215 lbs. of butter fat were pur-hased from our farmers at a figure repre-enting a second or an off grade price. This as 22.4% of the total amount graded and eant a loss of a little more than 5c per lb. t as compared to the average price for the ghest grade of fat for creamery purposes urchased during the same period, or a total nount of $89,070.20.

In the light of the foregoing one might ask "What can be done to lower this large amount of the inferior fat sold from our farms"? and "Wouldn't it be worth while financially to attempt methods that would ensure a larger return for labor spent"?

The work reported herein then is presented in the hope that it might serve as a demonstration of the value of the practising of methods long advocated. It establishes a correlation between various ways of handling cream at home and its grade in the creamery as recognized and defined today; and suggests a way to improvevment and better returns. Finally it is not its purpose to advocate new methods—rather to prove the old.

General Methods of Procedure

32 gallons of milk, as received daily from the College dairy barn and a patron who regularly furnishes the remaining part of the College milk supply, were dumped into an ordinary pasteurizer, heated to about 90° and then separated in a power separator. The cream was cooled and mixed and then divided into equal portions of about two quarts, each of which was added to a can that was being kept under control for a definite experiment. This was repeated each morning for six days, the fresh cream unless otherwise specified, being mixed with that already in the can at the time of the addition of more.

When two days' cream had been saved and held until the third day, but before the third day's supply was added, samples were obtained in plain glass tumblers for grading purposes. The third and fourth days' cream were added to the remaining portion in the cream cans and on the fifth day samples were obtained for a second grading. The fifth and sixth days' cream then were added and the cans allowed to stand over Sunday, the seventh day, without being hand-

led except in so far as to control temperatures. On the morning of the eighth day the cans were lined up and graded as in the regular creamery practice.

In all cases at the time of each grading the temperature and acidity of the samples were taken and then two graders, who were not informed as to the treatment the various cans had received, graded the cream, each establishing his grade independent of the other and the data were recorded.*

The cream was then turned into the regular creamery supply, the cans washed and the next series started.

Grades and Grade Standards

The grades of cream and the grade definitions accepted in this work are those recognized as official in the prairie provinces. They are as follows:

Table Cream

This grade shall include any lot of sweet, clean-flavored, non-frozen cream bought for re-sale for household use. The acidity of this cream shall not be more than twenty one-hundredths (.20%) of one per cent. at the time of grading.

This cream shall be produced under conditions that comply with the special requirements of the municipality in which it is to be sold for consumption.

Special Grade.

This grade shall include any lot of cream which is clean in flavor, of uniform consistency and suitable for making butter of this grade. Its acidity shall not be more than thirty one-hundredths (.30%) of one per cent at the time of being graded at the creamery where it is to be made into butter.

First Grade.

This grade shall include any lot of cream which is reasonably clean in flavor, of uniform consistency and suitable for making butter of this grade. Its acidity shall not be more than sixty one-hundredths (.60%) of one per cent at the time of being graded at the creamery where it is to be made into butter.

Second Grade

This grade shall include any cream that does not meet the requirements specified for the next higher grade; such as cream that is bitter, stale, musty, metallic, or otherwise unclean in flavor.

Off Grade.

This grade shall include any cream with an objectionable odor or flavor; such as kerosene, stinkweed, onions or such other flavors as may render cream unfit for making into number two butter.

I. The Effect of Temperature on the Grade of Cream.

In order to establish the relationship between the temperature of cream during the gathering period and its grade when it arrives at the creamery 102 gradings were made of cream held in different media for definite periods of time. One can in each series was taken from water in which ice was floating, the supply of ice being replenished twice daily and the temperature of the water recorded each time previous to the addition of ice. The highest individual record of the water at its warmest was 60°, the lowest 34° and the average of all daily readings over the seven weeks' period 42°. A second can of the same cream was held in water ranging in temperature at its warmest between 49° and 64° and averaging over the entire period 57°. It was changed twice daily and the readings were recorded likewise previous to replenishing the supply. A third can containing part of the same cream was kept on a cement floor in a place somewhat similar to the ordinary cellar. The temperature of the air was recorded regularly and ranged between 44° and 76° with an average of 64° at the time readings were recorded. The cream was tested for (1) temperature, (2) acidity, and the grade was established by two persons who were not aware of the treatment the various samples had received, with the results as tabulated in table No. 1.

From table 1 it is significant to note that in the 42 comparisons the acidity was higher in the warmer cream in every case and there

*The thanks of the author are hereby acknowledged to Prof. R. W. Brown and Mr. C. F. Shaw of this department who very kindly acted as graders for this work.

TABLE 1.

The Effect of Temperature on the Grade of Cream.

Week Ending		Av. and highest temperature of cream in			No. of grading	% acid in cream in			Grade of cream in		
		Iced Water	Water at 50 to 60 F.	Can on cement floor		Iced Water	Water at 50 to 60 F.	Can on cement floor	Iced Water	Water at 50 to 60 F.	Can on cement floor
May	5th	52	59	51	1	.10	.16	.12	T.C.	T.C.	T.C.
		54	60	58	2	.15	.44	.16	T.C.	1	T.C.
					3	.30	.48	.50	Spl.	1	1
"	"	"	"	"	1	.13		.14	T.C.		T.C.
					2	.21		.21	Spl.		Spl.
					3	.36		.62	1		2
"	12th	49	57	60	1	.12	.25	.31	T.C.	Spl.	1
		50	59	64	2	.13	.42	.45	T.C.	1	1
					3	.23	.48	.58	Spl.	1	1
"	19th	43	54		1	.12	.20		T.C.	T.C.	
		48	57		2	.17	.40		T.C.	1	
					3	.35	.50		1	1	
"	26th	48	58		1	.26	.44		Spl.	1	
		50	60		2	.26	.51		Spl.	1	
					3	.42	.57		1	1	
"	26th	48	58	64	1	.17	.39	.46	T.C.	1	1
		50	60	67	2	.17	.47	.50	T.C.	1	1
					3	.32	.66	.68	Spl.	2	2
"	26th	48		64	1	.25		.53	Spl.		1
		50		67	2	.38		.62	1		2
					3	.45		.68	1		2
"	26th	48		64	1	.17		.55	T.C.		1
		50		67	2	.17		.59	T.C.		1
					3	.35		.70	1		2
une	2nd	49	58	63	1	.14	.42	.53	T.C.	1	1
		57	58	68	2	.16	.53	.61	T.C.	1	2
					3	.30	.58	.62	Spl.	1	2
"	2	49		63	1	.15		.55	T.C.		1
		57		68	2	.16		.66	T.C.		2
					3	.26		.68	Spl.		2
une	9th	46	59	62	1	.13	.18	.23	T.C.	T.C.	Spl.
		48	61	63	2	.14	.50	.52	T.C.	1	1
					3	.16	.57	.60	T.C.	1	1
"	9th	46		62	1	.15		.44	T.C.		1
		48		63	2	.16		.62	T.C.		2
					3	.30		.68	Spl.		2
"	16th	46	61	70	1	.15	.34	.60	T.C.	1	1
		48	62	72	2	.16	.62	.71	T.C.	2	2
					3	.30	.70	.80	Spl.	2	off
"	16th		61	70	1		.44	.62		1	2
			62	72	2		.62	.69		2	2
					3		.68	.84		2	off

was enough difference in acidity to lower the grade by at least one grade in 33 cases, of which 19 were lowered by two and 4 by three grades. Furthermore in 25 comparisons a difference of from 7 to 15° and averaging 10° in the temperature of the cream held in ice water as compared to that held in water changed twice daily and controlled to not higher than from 59 to 62° at its warmest is responsible for the lowering of the grade by one grade in 6 cases, by two grades in 12 cases and by three grades in 1 case; while in 5 cases the grade was the same. These last mentioned 5 cases were for the most part at their first grading when the cream was fresh.

Of the 39 samples in iced water 22 graded "Table Cream" in spite of the fact that some of the cream was thin, and one third of the grading was on cream that had been in the process of being gathered for one full week and another third for five days while the remaining third of the comparisons was made on the third day. Eleven samples graded "Special" and 6 graded "first".

Likewise in a similar comparison of the 21 samples that were in water changed twice daily and in which the average temperature of the cream at the three successive gradings did not exceed 60°, there were 3 table cream, 1 special, 14 first and 1 second grades. The "Table" and "Special" grades were at the first grading when none of the cream was more than 2 days old and the 2nd grade was on cream that was from poorer milk.

However, when one considers the samples that ranged above 60° as the average temperature at time of grading, the grades were lower. Of the 27 gradings of cream standing on the cement floor where the temperature averaged from 62° to 70° in the various trials there were 15 seconds, 11 firsts and one special but no table cream grades even in the cream at three days old. In every case except one the acidity and staleness were so marked as to give a second grade at the third grading when the samples had been held a week. The same was true in 6 of the 9 gradings on the fifth day while one was lowered to a second grade on the 3rd day.

II. The Effect of the Percent Fat on the Grade of Cream.

That the richness of cream has a definite bearing on the grade can best be shown by a consideration of the results given in Table 2. Following separation and cooling each day, a portion of the cream was thinned by being mixed with the cooled skimmilk from the same separation in order to have cream of the same sanitary quality. The percentage fat was reduced thus by about one-third. The cans were placed side by side in water so that there ought not to have been anything other than the variation in the amount of fat and the consequent variation in the other milk constituents which would affect a change in the grade of cream. Some of the trials were in iced water while other comparisons were made in water at between 50 and 60°. Accordingly the grades remained higher throughout the series of three gradings in some cases than others. The grading was done on the 3rd, 5th and 8th days, respectively, as in the previous experiment.

TABLE 2.

The Effect of Percent Fat on the Grade of Cream.

No. of Trial		1		2		3		4		5		6		7	
% Fat	No of Grading	33	21	33	21	33	21	37	23	37	23	35	24	35	24
% Acid	1	.10	.13	.12	.14	.13	.15	.22	.26	.33	.54	.20	.25	.15	.17
	2	.15	.21	.16	.21	.16	.26	.45	.63	.48	.65	.40	.52	.45	.58
	3	.31	.36	.50	.62	.51	.62	.51	.68	.59	.70	.50	.63	.50	.74
Grade	1	T.C.	T.C.	T.C.	T.C.	T.C.	T.C.	Sp.	Sp.	Sp.	1	T.C.	Sp.	T.C.	T.C.
	2	T.C.	Sp.	T.C.	Sp.	T.C.	Sp.	1	2	1	2	1	1	1	1
	3	1	1	1	2	1	2	1	2	1	2	1	2	1	2
Times Grade Lowered		1		2		2		2		3		2		1	

It will be noted that in 21 comparisons the acidity was higher in the thinner cream in every case and the grade was lowered 18 times due to acidity alone.

III. The Effect of Cooling and Stirring on the Grade of Cream

A series of comparisons was made where one can contained cream that was cooled previous to adding to the can and was well stirred at the time of each addition. Another can contained cream that was not cooled and no effort was made to mix the fresh with the old. The cans were graded as in the previous experiment.

The results of the seven trials are given in Table 3. In general when the cream was fresh and still comparatively sweet very little difference could be noted. The acid invariably was one or two hundredths higher in the can containing the cream that was neither cooled previous to adding to the can nor stirred. The flavor on close examination likewise was more pronounced stale, but did not show enough difference to be of any consequence so far as the grade was concerned. The cream that received proper attention had a nicer body, but the difference was very slight, especially when both cans had received the stirring necessary to get a proper sample for testing. Of course these results refer only to cream not more than one week old at most and that held at a low or reasonably low temperature.

TABLE 3.

The Effect of Cooling and Stirring on the Grade of Cream.

Week Ending	No. of Grading	Flavour		% Acid		Consistency		Grade	
		C & S	Not	C & S	Not	C & S	Not	C & S	Not
May 5	1	cl.	cl.	.16	.16	Smooth	Smooth	T.C.	T.C.
	2	"	"	.44	.48	"	Chunky	1	1
	3	"	"	.51	.55	"	"	1	1
5	1	"	"	.12	.13	"	Smooth	T.C.	T.C.
	2	"	"	.16	.16	"	"	T.C.	T.C.
	3	"	"	.50	.51	"	Chunky	1	1
5	1	"	"	.14	.13	"	Smooth	T.C.	T.C.
	2	"	"	.21	.26	"	"	Spl.	Spl.
	3	Stale	Stale	.62	.68	"	Chunky	2	2
May 12	1	cl.	cl.	.25	.26	"	Smooth	Spl.	Spl.
	2	"	"	.42	.45	"	Chunky	1	1
	3	"	"	.48	.51	"	"	1	1
12	1	"	"	.31	.33	"	Smooth	Spl.	Spl.
	2	"	"	.45	.48	"	"	1	1
	3	Stale	Stale	.58	.59	"	Chunky	1	1
19	1	cl.	cl.	.20	.23	"	Smooth	T.C.	Spl.
	2	"	"	.40	.41	"	"	1	1
	3	Stale	Stale	.50	.53	"	Chunky	1	1
June 2	1	cl.	cl.	.53	.54	"	Smooth	1	1
	2	Stale	Stale	.61	.63	"	Chunky	2	2
	3	"	"	.62	.65	"	"	2	2

Note: The chunkiness or uneven consistency in no case was serious enough to be of any consequence. A thorough stirring would remove the chunks.

IV. The Effect of a Rusty Can on the Grade of Cream.

A can which was old and showed signs of rusting on the inside was used for holding cream to determine its effect on the grade of cream. Some of the trials were made in iced water, some in water at about 55° and some with the can sitting on the cement floor. In all cases a can which was new and properly tinned, containing some of the same cream, was used as a check. The results are tabulated in table No. 4. The metallic flavor was detected once at the first grading when two days' cream were in the can. In five cases out of seven it was marked at the second grading, while one of the remaining cases was described as not clean. At the third grading when the cream was a week old and

TABLE 4.

The Effect of a Rusty Can on the Grade of Cream.

No. of Trial		1		2		3		4		5		6		7	
Can	No. of Grading	Not	Rust	Not	Rust	Not	Rust	Not	Rust	Not	Rust	Not	Rust	Not	R
Flavor	1	Cl.	Cl.	Cl.	Cl.	Cl.	Met	Cl.	Cl	Cl.	Cl.	Cl.	Cl.	Cl.	C
	2	"	not Cl.	"	Met	"	"	"	Met	"	Met	"	"	"	M
	3	"	Met	"	"	"	"	"	"	"	"	"	"	stale	
% Acid	1	.12	.12	.25	.26	.25	.27	.52	.53	.15	.15	.16	.16	.34	.3
	2	.16	.16	.42	.45	.52	.56	.62	.67	.16	.17	.16	.16	.62	.6
	3	.50	.53	.48	.53	.63	.67	.68	.71	.26	.33	.17	.17	.70	.7
Grade	1	T.C.	T.C.	Spl.	Spl.	Spl.	2	1	1	T.C.	T.C.	T.C.	T.C.	Spl.	S
	2	T.C.	1	1	2	L	2	2	2	T.C.	2	T.C.	T.C.	2	2
	3	1	2	1	2	2	2	2	2	Spl.	2	T.C.	T.C.	2	2
Times Grade Lowered		2		2		2		0		2		0		0	

the acidity had developed the flavor was very noticeable and the grade lowered to 2nd in all cases except one. In that particular trial the acidity had not increased to any extent because of the low temperature at which the cream had been held throughout the period—the temperature of the cream being 45°, 44° and 48° respectively at the three successive gradings.

V. The Effect of Age on the Grade of Cream.

A glance at the data contained in any of the preceding tables reveals the effect that age has on the grade of cream, regardless of the ideal conditions that were provided in many of the cases. Summarized they show that the grade was lowered in 79 of the 154 possible cases where the cream was graded at successive gradings; and this in spite of the fact that the grade was low in many cases at the first or second grading due to a factor other than age, to ascertain the effect of which the specific experiment was carried on. In 31 cases out of a possible 58 where ideal conditions were provided and where the grade was used as a check with which to compare that resulting from various methods of handling cream the grade was lowered by at least one grade. The accompanying graph (chart 1) combines the effect of temperature and age on the grade of the cream. Whether the cream be held in iced water or not the grade is lowered invariably, due to the development of acid or an undesirable flavor which becomes more marked with age. The chart is self explanatory. It gives the actual res obtained in one definite trial where acid temperature determinations were recor daily. It demonstrates the same truth as shown in any of the preceding records of s cessive gradings of any sample of cream.

VI The Effect of Exposure of Tabl Cream to High Temperatures During Transit.

Since the grade of cream is determined delivery at the creamery an effort was m to ascertain the effect of removing cream fr iced water and exposing it to summer tem atures for varying lengths of time—an posure comparable to that the ordinary sh ment of cream receives, depending somew on distance from and train service to creamery. For this experiment table cre was held in iced water until it turned so Each morning temperature and acidity terminations were made, the ice supply repl ished, and a quart bottle filled and allow to stand on a table in the creamery throu out the day. The temperature in the crea ery ranged from 65° to 75° and would re resent about the temperatures that cream exposed to ordinarily in the baggage and express shed. Acidity tests were ma at 2 and 7 hour intervals and in a few cas at the 10 hour period and the data recorde

In a consideration of the results obtain in a study of 60 samples of table cream it interesting to note that these may be divid into two classes according as to whether not the increase in acid in the 7 hour peri

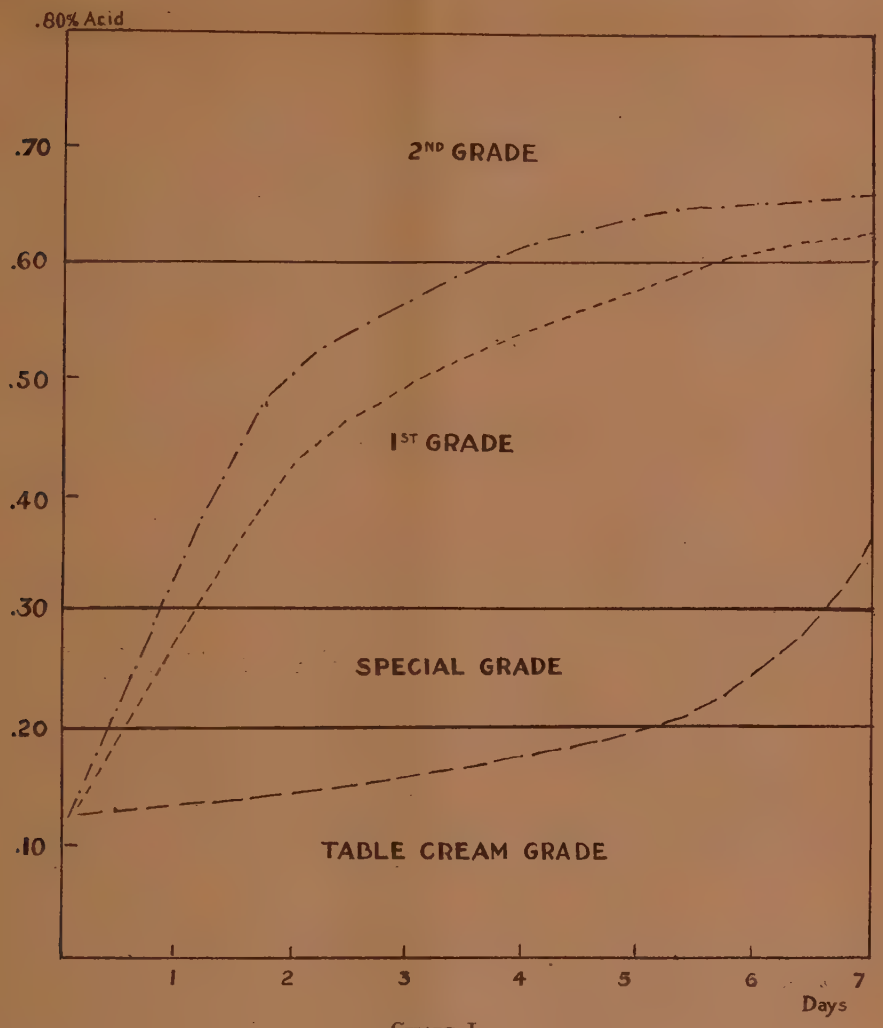


CHART I.

Grade of cream from acid alone as the result of (a) TEMPERATURE, (b) AGE.
——— In iced water ----- In water at 50 to 60°F. —·—·— On cement floor.

was sufficient to lower the grade of the sample. In 35 cases where the acidity of the cream ranged from .12% to .15% and in one case where it was .16% at the time of its removal from the iced water the grade was not changed; while in the 24 cases where the initial acidity ranged from .16% to .20% the grade was lowered to a special, two of which had passed into 1st grade before the 7 hours were up. At the 2 hour period the results were quite different. The samples showed scarcely appreciable change in acidity and accordingly the grade was the same as when first removed from the water. In one case however, where the acidity at first test was .20% or just at the maximum for table cream the grade was lowered.

In the 8 samples where tests were made at the 10 hour period also, the results were essentially the same. That is: where the initial acidity was low and the development of acid slow the grade remained unchanged and where it was higher and consequently developing more rapidly because of increased bacterial

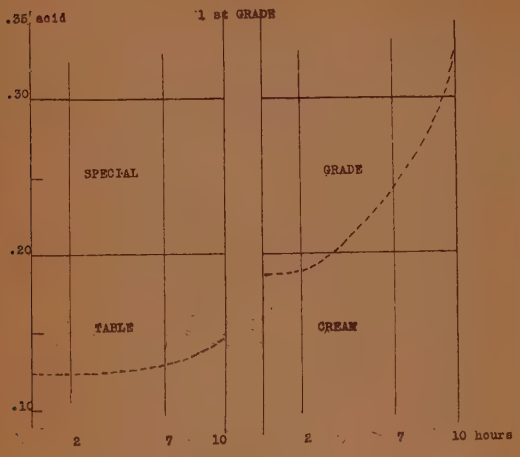


CHART II.

Both were table cream at the beginning. That on the left had .12% acid. In 10 hours it had .15% acid and was still table cream. That on the right had .18% acid. In 2 hours it had .19% and was still table cream. In 7 hours it had .26% acid and was special grade while before 10 hours it had lowered to the 1st grade.

activity the grade was lowered. Chart No. 2 represents graphically the results obtained in one typical example in each of the above classes. Furthermore it shows the effect of prolonged holding of the sample in a warm temperature on the increased rate of acid development.

Discussion of Results

The foregoing results demonstrate the practicability of delivering high grade cream to our creameries. They are to be accepted from the standpoint of what affects the quality of cream in a general and practical way, rather than that of establishing a definite relationship between grade of cream and any specific condition, over which the producer might find it difficult to obtain complete control. They show for example that with a sufficiency of ice floating in water the cream may remain sweet for a week in summer weather. The amount of ice used, the temperature of water available for cooling, the weather and temperature of the place in which the cream is held of course all affect the actual temperature of the cooling medium and that of the cream and consequently the grade obtained at the creamery. They prove the value of iced water as a cooling medium in preference to water that might be terme cold—50 to 60°—and furthermore they show the inferiority of air as a cooling medium Too, they point to the effect of age, of pro perly cooling and stirring of the cream, o fat content, of the condition of the can and of shipping facilities on the quality of the cream. But the handling of cream does no resolve itself to so narrow a task as con trolling any one factor. Rather it necessi tates a consideration of every condition that affects either the initial quality or the various changes that take place in cream; and the grade that one receives for his cream represents the sum total of these combined conditions which in the practical shipping of cream may be quite different from those included in these experiments. They serve the purpose however, of indicating the possibilities in affecting the grade of cream by a definite effort to control various conditions and show the comparative value of different factors on the ultimate grade.

Summary and Conclusions

An effort was made to show the importance of various methods of handling clean cream on its grade at the creamery. Cream was separated and assembled in the College creamery in the same way as it is under farm conditions except that the quantity was large enough to allow for several cans being filled at the same time, so that definite comparisons could be made. The cream was tested for temperature and acidity at regular periods; and its flavor and grade were determined independently by two graders who were not familiar with the treatment the individual samples had received. The grades used are those recognized by law as standard in at least four provinces of the Dominion.

1. Under practical conditions the colder cream can be kept during the gathering period the higher will be its grade. Where cream from the same separation was kept in iced water, in water held at between 50° and 60° and in a can sitting on a cement floor and graded on the third, fifth and eighth days respectively, the grade was lowered by at least one grade in 33 out of 42 comparisons made, of which 19 were lowered by 2 grades and four by 3 grades. This was the case in spite of the fact that one-third of the gradings was made when the samples contained

only two days' cream. The lowering of grade was the result in all cases of the development of sufficient acid apart from the factors of flavor and consistency which likewise might be responsible for a lowering of grade.

2. From the standpoint of keeping quality as determined by grade cream rich in fat is better than thin cream. In 21 comparisons of cream varying from 21 to 24% as against cream of the same sanitary quality varying from 33 to 37% the grade was lowered 13 times when grading was done on the third, fifth and eighth days. The lowering of grade was due to the greater increase in acidity. The remaining comparisons showed a higher acidity in every case in the thinner cream but the difference was not great enough to change the grade.

3. When the main supply of cream is cold, the cooling of what is to be added and the stirring after it has been added in themselves are not of great importance so far as a change in grade is concerned. The same is true when cream is reasonably fresh. In three successive gradings on seven trials where factors other than the cooling and stirring were identical the differences in acidity, flavor and consistency were not great enough to influence a change in grade. The sample that was neither cooled nor stirred however, invariably had the higher acid, the less desirable flavor and the greater tendency to be chunky when old and sour.

4. A can that has become dinted and is rusted or improperly tinned causes an undesirable metallic flavor in the cream, which lowers its grade to that of a second. This defect becomes more noticeable with age and the development of acid. The conditions which develop acidity as temperature, percent of fat in the cream and age accordingly are responsible for encouraging this defect. In seven trials the cream was pronounced metallic in 6 cases on the third grading, 5 cases at the second grading with another sample showing signs of developing an off flavor which the graders were unable to describe and one case on the first grading. The can that did not develop the metallic flavor was in very cold water—the cream registering 45°, 44° and 48° respectively at the three successive gradings.

5. The older cream is, the poorer in quality it becomes. In 31 cases out of a possible 58, where check cans were held under ideal conditions as far as temperature, cooling and stirring, richness of cream and condition of the can were concerned, the grade was lowered at the next grading. The remaining cans invariably showed an increase in acidity and a tendency to develop an old or stale flavor, but the difference was not great enough to lower the grade.

6. The removal of high quality cream from an ice cold medium and its exposure to normal transportation conditions are responsible for changing its grade in many cases. The shorter the period of time of exposure (and the colder the cream is at the outset and the cooler it can be kept) the less the possibility of a change in grade. Furthermore, the lower the acidity at the time it is taken from the cooling medium the less rapid the development of acid and the less the possibility of a change in grade. In 60 cases where cream of table grade (after having been removed from iced water) was exposed to conditions comparable to transportation conditions the grade at the end of the two hour period remained the same in 59 cases, the remaining case having had the maximum acidity for table grade at the outset. At the end of the 7 hour period 22 of the above cases where the initial acidity was from .16 to .20% had developed enough acid to grade Special and 2 enough to be First grade. The remaining 35 cases, where the initial acidity was .13 to .15% and 1 where it was .16%, had not developed sufficient acid to alter the grade. After 10 hours the trend of the acid development was the same, the rate being more rapid than earlier in the period.

ERRATUM

In the last issue of *Scientific Agriculture*, page 87, Peter's Formula for the probable error for a single determination should read:

$$P.E._s = \pm .8453 \frac{\Sigma + d}{\sqrt{n(n-1)}}$$

The Final Test For Nitrate of Soda.*

A. FULTON

Assistant to Dominion Fruit Commissioner, Ottawa, Ont.

The final test for any fertilizer is the actual results in dollars and cents obtained by the producer. It is a recognized fact that our Experimental Stations carry on most valuable and indispensible work in testing the merits and demerits of various fertilizers but not until the commercial test is performed is the actual value revealed.

The majority of horticultural specialists from the Atlantic to the Pacific Ocean agree that while nitrogen, phosphorus, and potassium may be available to our fruit trees, the one in particular that has given the positive results is nitrogen. According to the experimental plot and commercial orchard tests most of our fruit soils are bountifully supplied with the necessary plant foods for normal tree development with the exception of nitrogen which is required in some quickly available form. Nitrate of soda has been found to supply this urgent need of our orchard soils. The particular function of nitrogenous fertilizer applications is to produce heavier and darker foliage with a stronger, healthier wood growth, and the development of more and sturdier fruit buds. A liberal production of plump fruit buds is an indication that a favorable balance exists between the carbohydrates and nitrates. This ratio of carbohydrates and nitrates is found in healthy growing trees that develop large, smooth, prolific fruit buds which set and produce a profitable crop for the variety. It has been the experience of the writer that every tree in the orchard must be studied by the grower, as trees have their own contsitutional individuality like human beings. That is to say, each tree in the orchard should be given the quantity of nitrate of soda according to its ability to consume it economically. The amount to apply to a given tree varies according to age, the colour and size of leaves, the condition of bark, the wood growth and its bearing habit. In round figures the quantity to apply to bearing-aged trees will vary from three pounds to ten pounds per tree.

As fruit buds are formed early in the growing season it is important that the quickly available nitrate be applied while the soil nitrogen is inert. Nitrate of soda will supply the nitrate requirements in a form that is readily taken up by the roots of the trees. The time varies with seasons and different soil conditions—therefore no definite date can be set to cover all orchards. It was very noticeable the past spring, which was cool and backward, that nitrate applied on clay loam soils too early showed very negligible results on the trees. On the other hand applications on the same type of soil that received the nitrate two weeks later, which was in keeping with the late spring, gave pronounced results in leaf growth and colour. Generally speaking the time to apply the nitrate of soda is some time within a few weeks before the buds burst, with clay soils four to six days earlier than sandy soils.

EXPERIMENTS

To demonstrate the value of nitrate of soda as an orchard necessity for fruit production, a few experiments as conducted by the writer in the eastern Ontario apple belt, will be related. All the experiments described were conducted under commercial orchard conditions. In order to be explicit the experiments will be known as A, B, C, etc. Check rows were kept in each instance following the system of one fertilized row with three consecutive non-fertilized rows. The same orchard practises were followed for all trees. Where phosphoric acid was used the same system was followed.

Experiment A—

Size of orchard fertilized	4 acres
Age	12 years
Variety	Stark
Soil	Sandy loam
Sub Soil	Clay

*Awarded first prize by the Chilean Nitrate Committee in an essay competition, open to C.S.T.A. members.

FERTILIZER	Average quantity of fertilizer applied per tree 1st Year	2nd Year	3rd Year
Nitrate of Soda	4½lbs.	4 lbs.	4 lbs.
Phosphoric Acid	9 lbs.		

Early spring cultivation until July 10th followed by buckwheat as a cover crop.

RESULTS

First Year: No apparent results could be observed from the application of phosphoric acid. The nitrate of soda rows showed a great advantage over the checks in leaf growth, the leaves being darker in colour and 80 per cent larger, while the terminal shoots made an average growth of eight inches more than the non-fertilized. Fruit buds were observed to be larger on the fertilized rows.

Second Year: Leaves 100 per cent larger on the nitrated trees. Heavier blossoms with a slightly better fruit set. Yield in favour of the ntirate rows.

Third Year: On the nitrate of soda rows buds burst and were into growth eight days ahead of the check trees. A heavy blossom with a marked fruit set in favour of the treated rows. In all instances the trees had a more vigorous appearance with dark green foliage. The yield on the nitrate of soda rows averaged one bushel more per tree than the trees on the check rows.

Experiment B—

Size of orchard fertilized	100 trees
Variety	Golden Russet
Age	30 years
Soil	Deep Sandy loam

FERTILIZER	Average quantity of fertilizer applied per tree 1st Year	2nd Year
Nitrate of Soda	8 lbs.	8 lbs.

RESULTS:

First Year: All the trees had yellowish leaves and practically no terminal growth.

Yield Fertilized and Check Trees—Average .575 barrels per tree.

Second Year: Buds burst and were into leaf growth six days earlier on the nitrate of soda rows. The large, dark green leaves were very noticeable a considerable distance from the orchard making a sharp division with the non-fertilized rows which had a yellowish appearance. A very marked feature on the nitrate of soda rows was the length of the fruit pedicels which were twice as long as the ones on the non-treated trees. It has been observed by the writer that wherever the pedicels are long the fruit set is heavier, while short pedicels are usually followed by a heavy June drop. The fruit commenced to size quickly and continued throughout the season.

Yield Nitrate of Soda Rows—Average 2 barrels per tree.

Yield Check Rows—Average .75 barrels per tree.

Experiment C—

The most remarkable feature regarding this particular orchard is that the trees were 21 years old on commencing the experiment and had only borne one partial crop of apples during that period. After applying nitrate of soda as outlined below for three seasons the trees were brought into bearing, yielding, as the owner of the orchard states it, "four times more apples on the nitrate rows," in other words a ratio of 4 - 1 in favor of the fertilized trees. The particulars of the orchard are as follows:

Number of trees fertilized	270 Starks 90 Baldwins
Age	23 years
Soil	Heavy Clay Loam
Sub-soil	Clay

Fertilizer	Average quantity of fertilizer applied per tree 1st Year	2nd Year	3rd Year
Nitrate of Soda	7 lbs.	6 lbs.	5 lbs.

This orchard is located on a gentle slope towards the lake. It is tile under-drained. The terminal wood growth on the majority of trees was practically nil for 4 years before the nitrate of soda experiment, although they were sturdy and fairly healthy looking. During the three years this particular experiment was carried out the same rows of trees received the applications of nitrate of soda which was every fourth row with the three consecutive intervening rows acting as checks.

RESULTS

First Year: The nitrate of soda rows were easily distinguished by the dark green

foliage. The leaves were considerably longer and thicker. All the buds were extremely small which made it difficult to state which were fruit buds. The yield was negligible on all trees, averaging 5 barrels per row of 45 trees.

Second Year: It was most interesting to watch the trees bursting into growth the second spring. The buds on the fertilized trees commenced to swell and break into leaf seven days ahead of the non-fertilized. This was followed by the nitrated trees bursting into a beautiful uniform blossom while only a few scattered blossoms were to be found on the trees in the check rows. This was a most gratifying sight to the owners of the orchard although rather disappointing a little later when it was found that only a very light set of fruit had been maintained. This was attributed partially to the wet season and also to the trees themselves undergoing an internal change. Throughout the season the fertilized trees made luxuriant leaf growth along with a terminal wood growth averaging 8 to 10 inches longer than the non-fertilized. Fruit buds were formed in liberal numbers, being easily distinguished by the larger and rounder buds. At harvesting time the fruit was more plentiful and larger on the nitrate of soda rows.

Yield per row 42 trees—

	Fertilized	Non-fertilized
Stark	60 bbls.	4 bbls.
Baldwin	80 bbls.	None

Third Year: Again the nitrate of soda rows were in leaf a week ahead of the checks. Every fourth row of fertilized trees burst into heavy pink blossom which made a striking contrast with the three intervening check rows with practically no blossom. Throughout the season the trees were more vigorous with long, dark foliage. The owner informs the writer that the yield on the fertilized rows has averaged 4 barrels to 1 barrel on the non-fertilized rows or the trees supplied with the early available nitrate in the form of nitrate of soda have packed out four times more apples than the check row trees.

Yield per row 42 trees—

	Fertilized	Non-Fertilized
Stark	80 bbls.	15 bbls.
Baldwin	100 bbls.	30 bbls.

Experiment D—

Another very interesting test for nitrate o soda was carried out on one tree that wa among a block of trees that had their foliag badly burnt by lime sulphur spray. Th young bursting buds were burnt during th application of the delayed dormant spra which was an exceptionally wet period. Th buds and small leaves turned brown an dropped in many instances. One tree wa selected and 7 pounds of nitrate of soda was applied immediately after the burning was noticed. The remarkable thing about this tree is that it was forced immediately into leaf growth and blossom. The trees surrounding this fertilized one retained a burnt appearance a long time and dropped a great number of buds, although they eventually produced new leaves and some blossom. The leaves on the untreated trees remained yellowish while the tree supplied with the quickly available nitrate produced dark green foliage. The final test for the nitrate of soda was that this tree yielded 4½ barrels of apples while the untreated trees barely produced an average of 1½ barrels per tree.

CONCLUSIONS:

The foregoing experiments are just examples of several similar tests which amply demonstrate the high value of nitrate of soda in supplying the available nitrates at a period when it is required by the trees to bring about normal conditions for fruit production. Every test that nitrate of soda was put to gave almost immediate results in producing darker colored and more vigorous leaf growth. With fruit trees this is an indication that a constitutional change is taking place. Trees in run down condition require more nitrates and usually more time to recover, taking from two to three years to replenish sufficient reserve foods for crop bearing. Growers should not compare the comparatively slow results obtained by fruit trees with the quick growing vegetables except from the standpoint of increased leaf growth. Vegetables usually respond to nitrate of soda quickly when applied to most garden soils.

Experimenting with Grand Rapids lettuce, immediate results were obtained by applying nitrate of soda at the rate of 100 pounds per

acre which produced double the yield by increased leaf growth and, the most important, the crop was ready ten days earlier than the non-fertilized.

Practically the same result was obtained with Copenhagen Market Cabbage by applying nitrate of soda in two applications, twelve days apart, at the rate of 150 pounds per acre; the cabbages were better in all respects than the non-fertilized, being firmer, several days earlier and yielding 100 per cent. larger heads. With vegetables it is the edible leaf that is required while with fruit trees it is the large, green leaf that is necessary to manufacture the foods to provide the stimulus for fruit production.

Wherever nitrate of soda is supplied to plants its presence is revealed in some productive form which indicates that nitrogen is the lacking element.

Book Reviews.

PRACTICAL BACTERIOLOGY

An Introductory Course for Students of Agriculture

By Andrew Cunningham, *B.Sc. Agric.*

Advisory Officer and Lecturer in Bacteriology, Edinburgh and East of Scotland College of Agriculture.

(Edinburgh and London, Oliver and Boyd, 1924, 188 pp., 17 illustrations in the text.)

This is a very well arranged book covering the practical work for an introductory course in bacteriology for agricultural students. Its aim is to acquaint the student first with general bacteriological methods underlying the study of all branches of this subject, and then to introduce him to those special fields relating particularly to agriculture.

The first 100 pages, rather more than half of the book, are devoted to general technique under the following subdivisions:— preparation of culture media, microscopic technique, and cultivation and identification of bacteria. The exercises devoted to the use of the microscope and the microscopic examination of bacteria are specially well compiled, the author wisely laying stress on the importance of a thorough understanding of microscopical methods on the part of the student beginning work in bacteriology.

The remainder of the book consists of exercises devoted to the special fields of agricultural bacteriology. To dairy and soil bacteriology chapters of well chosen practical exercises have been given while the author has also introduced short chapters on plant and animal pathology.

The sections devoted to these special fields are short but necessarily so in a book of this type. For the student with training more comprehensive special works are available, but in this book the author has evidently kept in mind the necessity of arranging a practical introductory course capable of being covered in a college term. He has been successful in choosing a well-balanced first practical course upon completion of which the student may be well able to specialize in some particular direction.

Useful appendices are added dealing with the classification of bacteria and the preparation of reagents, etc. Some good illustrations are also included, though we should have preferred to see more. The whole book is written in a plain, lucid style and shows evidence of careful preparation. The field it covers suits it admirably for use as a guide for a preliminary college course in agricultural bacteriology.

A. G. L.

Le Musée Scholaire Agricole.

Sa Nature, sa Composition, son Utilité et son But

JEAN-CHARLES MAGNAN

Sa Nature

Le musée scolaire agricole, à notre sens, est une *collection* rudimentaire d'objets ou d'échantillons, servant à l'éducation et à l'instruction de la jeunesse rurale; le tout se rapportant aux choses champêtres.

Ce matériel peut se loger dans une petite armoire en bois, une cassette ou encore dans le tiroir d'un meuble réservé à cet effet dans la salle de classe. La plupart des objets et échantillons du musée sont étiquetés soigneusement par le maître.

Ce musée ne doit pas être "une collection de curiosités, d'objets rares, destinés à frapper l'imagination des visiteurs; il ne doit comprendre que les échantillons pouvant réellement servir à l'instruction de l'enfant."

Sa composition

C'est par le maître, aidé des élèves que le musée est constitué.

La composition du musée varie avec les circonstances, les cultures locals ou les régions: sa formation est laissée au discernement de l'instituteur ou de l'institutrice. Les objets recueillis par le maitre ou apportés par les élèves, sans bourse délier, pourraient comprendre:

1—Un échantillon de chaque nature de terre: argileuse, sablonneuse, humifère (terre noire), calcaire et franche;

2—Une collection des insectes utiles et nuisibles de la région;

3—Un herbier renfermant (selon la région):
A., les principales plantes nuisibles,
B., les principales plantes utiles (céréales, graminées);

4—Les différents grains (et graines) semés par les cultivateurs de l'endroit;

5—Des images, catalogues, représentant les plantes, les animaux domestiques, les oiseaux, les instruments aratoires, les fruits et légumes, etc.; des gravu res reproduisant de jolies scènes champêtres. Ceci, amassé avec le temps et choisi avec goût.

Il est facile, chacun le conçoit, d'établir ce musée à peu de frais, même dans la plus modeste école de paroisse.

Son utilité et son but

Au chapitre de la Section agricole du "Programme d'études de l'Ecole primaire complémentaire de la Province de Québec," il est fort bien dit: "Les travaux pratique au jardin scolaire et au jardin familial, l constitution de collections et d'herbiers, son autant d'exercices d'une grande utilité pou raffermir et accroître l'enseignement théori que de l'agriculture. L'observation et l'ex périmentation joueront ici un très grand rôle" Et, plus loin: "Tout cet enseignement doi tendre à donner à l'élève des connaissance pratiques qui le prépareront à la carrièr agricole qu'il suivra plus tard."

Lors des leçons théoriques ou pratiques, l matériel du musée scolaire nous est d'un précieux secours pour l'enseignement d l'agriculture au élèves. Au moyen des ob jets de ce musée, il est plus facile de rendr notre objets de ce musée, il est plus facile d rendre notre enseignement instructif, agréable et profitable aux enfants. D'ailleurs, nous nous appuyons sur le principe pédagogique qui veut "que l'enseignement du maître soi concret, imagé, vivant", afin de mieux at teindre l'imagination et l'esprit de l'élève.

Entre parenthèse, à part l'instruction don née aux enfants par l'enseignement de l'agri culture, nous pourrions ajouter qu'il y a moyen, *par la Terre*, de faire naître chez eux le *sens esthétique* et de le cultiver: "Il s'agit d'éveiller dans l'âme de chaque enfant *ce sentiment du beau*, présent, inégalement sans doute mais réellement, en toute personnalité.

Il s'agit de faire sentir aux enfants qu'il y a dans la vie mieux que de l'utile, autre chose que du vrai, qu'il y a aussi de la beauté. Il s'agit de protester contre l'éducation purement intellectuelle et utilitaire qui nous envahit."

Par cette éducation, l'enseignement primaire rural aurait un *adjuvant précieux* de formation, au service de la jeunesse des campagnes de la Province de Québec. Nous connaisons les efforts méritoires du personnel enseignant au sujet de la formation du sentiment esthétique. Que les futures institutrices imitent ce geste biefaisant.

L'école rurale remplira en partie sa mission, si l'institutrice utilise tous les moyens à sa portée (le musée scélaire en est un...) pour *faire aimer et comprendre le sol de chez nous*, à la génération qui nous succèdera.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

The names and addresses of all those who have joined the Society since June, 1924, are listed below. Practically all of these are in response to the membership campaign undertaken by Dr. G. C. Creelman in October.

Geo. J. Callister (Toronto, 1921, B. S. A.) Ithaca, N.Y.

W. J. Price (Toronto, 1899, B.S.A.) Orangeville, Ont.

A. C. Wilson (Toronto, 1897, B.S.A.) Springfield, Ill.

E. A. Atwell (McGill, 1923, B.S.A.) Dom. Lab. Plant Pathology, Charlottetown, P.E.I.

C. Bouchard (Laval, 1917, B.S.A.) Dom. Exp. Station, St. Anne de la Pocatiere, P.Q.

N. M. Blaney, (Toronto, 1923, B.S.A.) Sask. Cooperative Creamery, Regina, Sask.

J. MacF. Bates, (Toronto, 1923, B.S.A.) Beamsville, Ont.

Jos. Ficht, (Alberta, 1924, B.S.A.) University of Alberta, Edmonton, Alta.

C. D. Flatt, (Sask. 1924, B.S.A.) Sask. Cooperative Creamery, North Battleford, Sask.

J. J. Gautreau, (Laval, 1916, B.S.A.) Dept. of Agriculture, Quebec, P.Q.

W. R. Graham, (Toronto, 1894, B. S. A.) O.A.C., Guelph, Ont.

R. B. Hinman, (Toronto, 1915, B.S.A.; Iowa, 1920, M.S.) Cornell University, Ithaca, N.Y.

H. R. Howard, (Toronto, 1923, B.S.A.) Galt Chemical Products Ltd., Galt, Ont.

W. F. Jones, (Toronto, 1923, B.S.A.) Dept. of Agriculture, Ottawa, Ontario.

C. P. Killick, (Sask. 1924, B.S.A.) Regina, Sask.

W. V. Longley, (Toronto, 1911, B.S.A.) 369 Robert St., St. Paul, Minn.

A. R. Marston, (Toronto, 1923, B.S.A.) Caledonia Springs, Ont.

D. J. Matheson (Toronto, 1919, B.S.A.) Dept. of Agriculture, Petrolia, Ont.

H. A. Morgan, (Toronto, 1889, B.S.A.) President, University of Tennessee, Knoxville, Tenn.

G. W. McCall, (Toronto, 1919, B.S.A.) S.S.B., Toronto, Ont.

W. J. Stephen (Manitoba, 1913, B.S.A.) Dept. of Agriculture, Edmonton, Alta.

G. A. Scott (Toronto, 1923, B.S.A. McGill, 1924, M.Sc.) Perth, Ont.

R. D. Sinclair, (Alberta, 1918, B. S. A.) University of Alberta, Edmonton, Alta.

T. H. Sharp, (Toronto, 1903, B.S.A.) 610 Carleton Ave., Westmount, P.Q.

O. Schafheitlin, (McGill, 1914 B.S.A.) Canning, N.S.

C. T. Tapp, (Alberta, 1919, B.S.A.) Dom. Seed Branch, Calgary, Alta.

J. E. Whitelock, (Toronto, 1922, B.S.A.) Agricultural Representative, Brampton, Ont.

G. A. Williams, (Toronto, 1921, B.S.A.; Iowa, 1922, M.S.) Purdue University, Lafayette, Ind.

LOCAL BRANCH MEETINGS.

With the close of the summer season practically all of the local branches have arranged their winter programme and will hold meetings at regular intervals.

The Eastern Ontario local will hold regular monthly meetings throughout the winter. The first of this series was held on November

7th, when an address was given by Dr. J. A. Ruddick, Dairy & Cold Storage Commissioner.

The Fall meeting of the British Columbia local was held at Braemar School, Vancouver, on October 28th, occupying the afternoon and evening. The Secretary reports that this was one of the best meetings the branch has yet held.

The Montreal local (French) will hold monthly meetings at the Laval University Club on the first Saturday of each month, opening with a luncheon. The first of these was held on November 8th.

The Manitoba local has already held two monthly meetings, the first being addressed by W. C. McKillican, who was recently appointed Dean of the Faculty of Agriculture at the University of Manitoba, and the second, on November 17th, by Dr. A. Savage, Professor of Animal Pathology at the Manitoba Agricultural College. The next meeting, which will be held early in December, will be addressed by President McLean of the University of Manitoba.

C. S. T. A. BOOTH AND BANQUET

The C.S.T.A. booth at the Royal Winter Fair in Toronto proved to be quite a popular innovation. It was visited by members of the Society from all parts of the Dominion and there is little doubt that it will be provided each year for the convenience of members.

The banquet at the King Edward Hotel on the evening of November 20th, which was arranged with the cooperation of the O.A.C. Alumni Association, was extremely successful. There was an attendance of 160. Addresses were given by Dr. G. I. Christie Director of the Agricultural Experiment Station, Lafayette, Ind., and by Premier G. H. Ferguson of Ontario. Entertainment of a most enjoyable character was provided by George Patton and his assistants. Mr. W. B. Roadhouse, Deputy Minister of Agriculture, acted as Chairman.

1925 CONVENTION

The dates for the Fifth Annual Convention to be held at the University of Alberta, will be June 24 to 26, inclusive. It will be preceded by the Annual Meeting of the Canadian Seed Growers' Association on June 22nd and 23rd. The arrangement of the C.S.T.A. programme will be undertaken immediately after the new year.

TEXT BOOK CLUB.

The attention of members is again directed to the fact that they may purchase agricultural books through the office of the General Secretary, at a discount of 20 per cent. below list prices. The Society pays all charges for postage. All publishing houses are cooperating in this arrangement, and the advertisements of five of the leading publishers of agricultural books will be found in this issue.

MEMBERSHIP IN A. A. A. S.

In 1922 the C. S. T. A. was admitted to affiliation in the American Association for the Advancement of Science, and has one of its members on the Council of the Association.

The A.A.A.S. admits eligible members on payment of an entrance fee of $5.00 and an annual fee of $5.00, but a special privilege is being given to members of affiliated Societies so that they may join without the payment of any entrance fee. This privilege expires on January 1st, 1925, and will not be renewed for at least five years. Members of the C.S.T.A. who wish to join the American Association should do so immediately in order to take advantage of this privilege. Membership in the A.A.A.S. includes free subscription either to the weekly *Science* or the *Scientific Monthly*.

A booklet of information on the A.A.A.S., sample copies of the journals, or any other particulars desired, can be obtained from the Permanent Secretary, Dr. B. E. Livingston, Smithsonian Institution Building, Washington, D.C.

The Nature of the Growth Rate in Plants.*

(A Review)

W. F. HANNA,

Department of Field Husbandry, University of Alberta.

INTRODUCTION

The importance of environmental conditions in determining the nature of plant growth has long been recognized. The process of natural selection which is continually going on is but an expression of the effectiveness of these conditions to react upon plant life. In many instances the distribution of various types of vegetation is clearly due to the different climatic factors which have been at work. For example, the distribution of genera and species within that broad belt of coniferous forest which stretches across Canada, while in some cases influenced by competition, variations in soil type, and differences in altitude, is very often directly related to such climatic conditions as precipitation, wind velocity, temperature, atmospheric humidity and sunlight. But these results have been brought about by the constant application of such elements over long periods of time. Of the fluctuations which occur in the growth rate of an individual plant from day to day and from hour to hour, due to the accelerating or retarding influence of climatic changes, but little is known. The ordinary records of climate, useful though they may be in some respects, are of limited value in interpreting plant growth unless coupled with data for corresponding physiological activities in the form of growth measurements. A knowledge, therefore, of the manner in which the growth of economic plants is affected by fluctuations in climate should be of considerable practical value.

A study of the geographical distribution of a particular species should give a rough indication of the relation which it bears to its environment. In this connection reference might be made to two well-known agricultural plants, namely, corn, *Zea mays*, and the sunflower, *Helianthus annuus*. The clearly marked distribution of corn suggests at once that quite high temperatures during the growing season is one of the conditions necessary for its successful culture. The sunflower, on the contrary, has no such distinct zone of culture. Although considered by most authorities as a native of the Great Plains Region from Nebraska to Mexico, it has now quite a scattered distribution as an agricultural crop. In 1615 Champlain observed it being cultivated by the Hurons in Canada. About the middle of the sixteenth century the plant was introduced into Spain from America. It is now grown extensively throughout North America, Russia and Hungary, and to a limited extent in China, Australia, New Zealand, South Africa, Egypt and India. While the location of its original habitat suggests that the plant thrives best in regions of high temperature, its present distribution shows that it can be grown successfully under a great variety of conditions.

REVIEW

Growth Measurements

The manner in which growth measurements are carried out is of considerable importance. If stem elongation over a relatively short period of time is taken as a measure of growth, it will, in most cases, be found that the maximum amount of growth takes place in the absence of light. In this case growth is but a measure of the rate at which materials already elaborated by the plant are translocated and rearranged. Prescott (25), working on the growth of maize in Egypt, found that the growth rate, measured by increase in height, exhibited two maxima during the twenty-four hours, one a short time after sunrise and the other in the late afternoon about sunset. The total growth however, during the twelve night hours from 8 p.m. to 8 a.m., was generally found to be greater than that during the remaining twelve hours of daytime. If, on the other hand, increase in dry weight is taken as a measure of growth, or even stem elonga-

* This paper constitutes the introductory portion of an M.Sc. thesis on "The Growth of Corn and Sunflowers in Relation to Climatic Conditions." A summary of the experimental data will be found in Botanical Gazette, Vol. 78, No. 2, pp. 200-214, Oct. 1924.

tion over a period of several days, the former must give an accurate, and the latter an approximate measure of the plant's ability to produce new materials, from the compounds present in air and soil.

Internal Factors

Before considering the probable influence of external factors such as climate upon the rate of growth, a clear conception is necessary regarding the part played by certain tendencies resident within the plant itself—the internal factors. Lying dormant within the seed are certain genetic tendencies, which when expressed later during the life of the growing plant, tend to produce under any given set of external conditions, a certain definite form of growth. It is only reasonable to believe then, that the role of external conditions is merely that of accelerating or retarding the manner in which the internal factors tend to express themselves. F. F. Blackman(2) in pointing out the power which protoplasm possesses of renewing and increasing itself, has compared the growth of an organism to the process of autocatalysis. In the multiplication of bacteria for example, this author points out, the increase in number, which is a fair measure of the total increase in mass, assumes for a time the form of a strictly logarithmic curve. In the higher plants it might be expected that the extreme degree of differentiation and specialization in tissue would prevent any such regular increase in mass. Reed and Holland(26) however, found that the rate of stem elongation in *Helianthus*, as determined by weekly measurements, followed strictly the course of an autocatalytic reaction as expressed by the formula—

$$log \frac{x}{A-x} = K (t-t_1)$$

where A represents the final mass of the plant, x the size of the plant at any time t, t_1 the time at which the mass of the plant is half the final mass, and K a constant. The close similarity between the observed and calculated values in this work is indeed striking, and led the authors to conclude that the growth rate is governed by constant internal factors rather than by external factors. Reed (27) has applied the same formula to the growth of pear shoots (*Pyrus communis*) and young walnut trees (*Juglans nigra* and *Juglans regia*) with good results. The formula was also found to be applicable to data c maize collected by Kreusler, the calculate values bearing a similarity with those o served whether mean height, mean gree height, or mean dry weight was taken as measure of growth. Finally Reed (27) en ployed the formula successfully in connecti with certain data published by Eckles an Swett (11) on the growth of dairy heifer But, as pointed out by West, Briggs and Kid (28) the above formula involves the assum tion that the falling off in growth per un of dry weight is due to the disappearance a catalyst. In the absence of direct evidenc to support this view they contend that th decrease in the growth rate is possibly du to an increasing differentiation into produ tive and non-productive tissue. Working r cently with *Helianthus* (17), they have show that the respiration index of the meristemati tissue as well as that of the whole plant fall off with age. The curve for respiration, mor over, follows closely the falling growth rat curve. This suggested that the decrease i growth rate towards the end of the life cycle i not wholly due to an increase in water co ducting and mechanical tissue.

The "compound interest law" of growth ha been put forward by V. H. Blackman (3, 4 as expressed by the formula:

$$W_1 = W_0 e^{rt}$$

when W_1 is the dry weight of the plant at th end of time t, W_0 the initial seedling or see weight, r the rate of interest, and e the bas of the natural logarithms. The value of r ha been termed by Blackman as the "eff ciency index" of dry weight production, repre senting the efficiency of the plant as a pr ducer of new material. According to thi formula the increase in dry weight takes plac exponentially and all of the new materia added by the plant is equally effective in pr ducing new growth. For the data originall examined by Blackman fairly constant value of r were found during the active growin period of the plant. But Kidd, West an Briggs (16) have applied this formula i examining the growth rates of several plants and find that not only does the efficiency inde fluctuate from week to week, but that i tends generally to decrease in value from a period quite early in the growing season. A examination of the data presented by Brench ley (6) for the growth of peas also show

that the value of r undergoes quite violent fluctuations.

Briggs, Kidd and West (7, 8) in carrying out an analysis of data collected by Kreusler on the growth of maize, calculated the growth rate by means of the following formula—

$$\frac{R}{100} = \frac{W_2 - W_1}{W_1}$$

where W_1 and W_2 are the dry weights of the plants at beginning and end of the week, respectively. This is essentially a simple interest method of calculating growth rate. It gives the rate of increase in dry weight for the period, as a percent of the dry weight at the beginning of the period. Fisher (12) has criticized the use of this formula and pointed out that in some cases it introduced errors up to one hundred percent. He maintained that Blackman's compound interest formula expresses correctly the growth rate of the plant. Should it be necessary to express growth as taking place on the linear basis, he believed that the growth rate should be calculated as a perecnt of the mean value for the period according to the formula

$$\frac{R}{100} = \frac{2\,(W_2 - W_1)}{(W_1 + W_2)}$$

Both the simple and the compound interest formulae are based on the assumption that the new material produced by the plant is employed as capital in a certain definite manner, in the former case at stated intervals, and in the latter continuously. In neither instance does the method of calculation give more than an approximation.

The relative growth rate curve for maize presented by Briggs, Kidd and West (7, 8) from Kreusler's data, shows that for the two or three weeks following germination the growth rate is either very small or negative in quantity. Following this period there is a rapid increase in the growth rate until it reaches a maximum, when it falls again to a very low value at the end of the season. In the falling part of the curve, however, are two subsidiary maxima which are found, in general, to be coincident with the appearance of male and female flowers, an event probably preceded by increased respiration which resulted in the minima immediately preceding the subsidiary maxima. When the curve for leaf area, i.e., the ratio of leaf area to dry weight, is plotted for the same dates it is found to follow closely the form of the growth rate curve. This similarity in the form of the two curves suggested to the authors that the increase in dry weight per unit of leaf area was approximately constant throughout the life cycle of the plant. In order to test this supposition the "unit leaf rate", i.e., the increase in dry weight per square centimeter of leaf surface, was calculated for the same period. On the assumption that leaf area is a measure of the active growing tissue, the capital, so to speak, which the plant employs, the unit leaf rate curve should have been a straight line parallel to the time axis. But the authors point out that the assimilation of young seedling leaves is relatively small per unit of surface; also the dry weight per unit of leaf area falls at first and then rises to a maximum at the end of the life cycle. These two tendencies coupled with the fact that rspiration per unit of dry weight decreases with age, would have the effect of making the unit leaf rate curve assume a concave form relative to the time axis. The curve obtained follows this general form in the early period of growth, but subsequently fluctuates violently and fails to show any particular tendency. This, the authors have shown to be due in all probability to errors in sampling.

While this work leaves the problem of plant growth formulas still unsolved, it marks a distinct advance by unraveling some of the many internal factors responsible for plant growth.

External Factors

Of the climatic conditions influencing growth, probably the most important are precipitation, atmospheric humidity, temperature and light. In most of the investigations carried out on this subject, the conditions in regard to moisture have been kept in excess either by irrigation or by growing the plants in water culture, so that little information is available regarding the effect of precipitation at different periods in the life cycle of the plant. An examination of the charts prepared by Prescott (25) on the growth of maize in Egypt shows the immediate response which the plant makes to irrigation during the period of rapid growth, when soil mois-

ture has become a limiting factor. The work of Briggs and Shantz (10) emphasized the great variations which different groups of plants exhibit in respect to water requirement. They have reported the results obtained by Wollny at Munich, who found the water requirements of corn and sunflowers to be 233 and 490 respectively.

Atmospheric humidity or more properly, the evaporating power of the air, is one of the factors chiefly responsible for water loss by the plant through transpiration. But with a constant amount of water vapour in the air, the degree of saturation must vary inversely with temperature. The important thing to consider therefore, is the vapour tension deficit of the atmosphere for the particular temperature considered. Livingston and Shreve (19) give a thorough review of this topic and suggest certain methods of employing data on evaporation for the study of plant growth and distribution. McLean (20) in studying the growth of soybean cultures as a measure of the growth producing power of the climate of Maryland, found that the ratio of evaporation to rainfall became quite often a limiting factor for growth. This was especially noticeable towards the end of the growth period, when high temperatures prevailed. The general methods employed by McLean have been adopted by Johnston (15) in a study of the growth of buckwheat, *Fagopyrum esculentum*, under greenhouse conditions. He found that the high evaporation rates of late summer occurring with high temperature and transpiration values, were responsible for low rates of increase in dry weight and in leaf area.

Besides furnishing energy for the photosynthetic activity of the plant, light is undoubtedly one of the most important external factors influencing transpiration. While only about 0.5 percent of the radiant energy falling upon the leaf is utilized in the process of carbon assimilation, Palladin (24) states that 27.5 prcent is usd up in transpiration. A close correlation between assimilation and light of high intensity is therefore scarcely to be expected. Brenchley (6), experimenting with the growth of pea plants under greenhouse conditions, found good correlation between bright sunshine and the rate of increase in dry weight calculated by Blackman's (3) compound interest formula, provided the food supply was adequate. Brig Kidd and West (8) found the closest corre tion between unit leaf rate (increase in weight per unit of leaf area per week) a light, when intensities up to one-fifth f sunlight were considered as limiting. T correlation with total hours of sunshine v insignificant. The value for real assimilati was calculated from the unit leaf rate, af adding the loss due to respiration, and dedu ing the gain due to salt uptake. When t value obtained was compared with light tensity, there seemed to be little correlatio no matter how light was measured. Th led the authors to suppose that under natu conditions, light limits the growth rate n by its direct action upon photosynthesis b indirectly through its effect upon stomat openings. Recent experiments by Garner a Allard (13) have shown that the relati length of night and day is of great importan in determining the amount of vegetati growth and the time of reproduction. Th brings up the question of the dates of see ing of different crops in order to obtain ma imum yields of fodder or seed.

Temperature has the effect of acceleratin most chemical reactions. The acceleration reaction velocity, moreover, is logarithmic nature. This phenomenon has been summe up in the rule known as the Van't Hoff pri ciple, which, in brief, states that for ever rise of 10°C the reaction velocity is approx mately doubled. This principle has bee found to hold true in the case of many vit reactions. F. F. Blackman (1) discusses th principle in relation to assimilation and re piration, and points out the necessity of co sidering also the time factor. Especially this true in the case of assimilation, as th initial rate falls off rapidly at high tempera tures. It has generally been supposed tha a certain optimum temperature exists for th process of growth in a given organism. Bu Blackman (1) shows the futility of consider ing a single limiting factor such as tempera ture unless in relation to other possible limit ing factors. Probably the most careful wor on the problem of temperature and growth has been carried out by Lehenbauer (18) i his study of the growth of maize seedling. I general, he found that the amount of growth increase per unit of time at a given tempera ture was influenced by the duration of th

posure to that temperature. With an exure period of twelve hours the optimum mperature was found to be 32°C. One ticeable feature of these measurements is t for most of the temperatures up to and cluding 31°C. the growth rate per period time increases quite regularly from hour hour. This suggests that had the increase r each period been expressed as relative owth rate, a more constant series of values uld have been obtained. McLean (20), ldebrandt (14), Prescott (25) and Briggs, dd and West (8), all found a high corlation existing between temperature and owth under field conditions. Brenchley) and Johnston (15) obtained similar reIts when investigating greenhouse condins. The failure of Reed and Holland (26) establish any intimate relation between mperature and the rate of stem elongation *Helianthus* may have been due to the fact at in California where temperatures would turally be uniformly high, other factors ight have been limiting growth. The relan of temperature accumulations expressed degree days, to time of blossoming in the ple and peach, has been studied by Bradrd (5). He found that the agreement in mperature accumulations to blossoming om year to year at any one place, varies th the length of the time for which they e measured, indicating that ordinary temratures are not always affective, or that mperature is not always a limiting factor. osier (22), in his study of the climate of linois, has used degree hours to express mperature accumulations for the frost free riods, considering 49°F. as the point of it growth rate for corn. Although lower elds occurred during the years of high mperature, he found that high temperatures uld be correlated with low rainfall. In a cent work Livingston and Shreve (19) have ade use of various temperature indices in attempt to correlate different vegetational gions in the United States with environntal conditions. Summations of tempera-re for numerous stations, according to the fferent indices, were obtained, by employg the information accumulated in meteorogical literature. In some cases the temrature indices were employed in connection th similar data on evaporation and precipiion, thus giving a series of combined inces. The whole country was then divided into zones according to the magnitude of the various summations obtained. While this work was essentially a study in ecology, the methods employed promise to be of considerable value in connection with any general study of climatic conditions and the rate of plant growth.

In general, while each individual plant has its particular form of growth as influenced by various groups of internal factors, it is only reasonable to expect distinct fluctuations in the growth rate curve from day to day, brought about by changes in climatic environment. Moreover, the magnitude of the effect produced by climatic changes will depend to a considerable extent upon the stage of development reached by the plant. That is, the effect of any single climatic factor such as temperature, is influenced in its action upon the plant by its relation to other climatic factors, and to the internal condition of the plant.

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he Role of Calcium in Dunkirk and Volusia Soils.*

J. AUGUSTE PEPIN

Dominion Seed Branch, Ottawa, Ont.

mongst the practices intended to keep soil fertility, liming is one of the oldest. lime problem has maintained to the pre- time a prominent place in the science of s. The general conception of the role lime in the soil remains somewhat con- ed, on account of the extreme complexity dissimilarities of soils.

n this respect, the Dunkirk and the Volusia ls, which are both of a glacial origin, and be found side by side in southern New rk, present an interesting problem. Both ls respond to liming in the field. It has n occasionally observed, however, that Dunkirk does not always respond to the atment in the greenhouse, in which respect differs from the Volusia.

REVIEW OF LITERATURE

The problem of liming has generally been ociated with that of soil acidity. Mac- yre (1921) points out that "the acidity soils is, in the main, induced by the loss calcic and magnesic inorganic salts, de- ed originally from the hydrolysis of the ali-earth siliceous complexes, thereby in- asing the acid properties or amount of id silicates".

The role of acidity itself in plant growth as been discussed lately by Tarr and Noble 1922), and Bryan (1922-23-23). Their re- ults seem in accordance with McCall's 1923) statement that: "the optimum reac- on for most field crops is just below neutral- y, and that the depressing effect of soil cidity is exerted more on the soil organisms han upon the crop plants".

Christensen (1911) found that the absence f Azotobacter in acid soils is so general that can be taken as a positive test for soil acid- y.

Gainey (1918), and Gainey and Batchelor 1922) report that the maximum H-ion con- entration tolerated by the azotobacter is pH .9-6.0.

The nitrifiers appear to be less sensitive to acidity than do the azotobacter. Barthel (1919) found, after Fred and Temple, that the nitrification of manure can be very in- tense in acid soils.

Noyes and Conner (1919) report that the nitrifying power of five acid soils varied with the organic matter and total nitrogen con- tent rather than with the soil acidity. They found, however, with Neller (1920), that liming increased nitrification and the oxidiz- ing power of the soil.

Miyake (1916), Hartwell and Pember (1918), Mirasol (1920), Conner and Sears (1922) have reported the toxicity of alum- inum as a factor possibly responsible for the unproductivity of certain acid soils.

Gile (1923) and Whiting (1923) recently made a critical review of the experiments reported on aluminum toxicity, and arrive at somewhat different conclusions.

As to the best way to immobilize aluminum in soils. Conner's (1921) results suggest that the calcium phosphates and silicates are more effective than the carbonate and the hydroxide, in this respect; while Burgess (1923) claims that "both lime and soluble phosphate applications are needed to depress greatly the activity of aluminum in certain acid soils".

Conner also mentions iron, manganese, zinc and boron, as possible toxic elements to be found in soils, and counteracted by liming. The comparatively little attention these ele- ments have received is probably justified by their limited occurrence as toxic substances in normal soils.

Hill (1922) recently revives Loew's (1901) idea of the possibility of unfavorable cal- cium-magnesium ratios to be corrected by liming. Dolomitic and calcareous limestones have been used almost indiscriminately of

* A Thesis submitted to the Faculty of the Graduate School of Cornell University, in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

late, after Lipman (1914) and his associates, and others, had reported as good, or even better results with magnesian than with non-magnesian limestones. MacIntire and Young (1923) point out the "transient nature of magnesium-induced toxicity".

Schreimer (1923), discussing the toxic organic substances in soils, points out that: "Liming neutralizes the soil acids, but it also promotes the oxidation of aldehydes (which are toxic) since these oxidation processes proceed more readily under alkaline conditions".

It is generally agreed that the presence of toxic organic substances, whether acid or non-acid, are very uncommon in well drained and aerated mineral soils.

Plummer (1921) reviews the important investigations on the effects of lime on the availability of potassium and phosphorus, and concludes that they "have failed to show that basic compounds of calcium and magnesium increase, by chemical action, to any practical extent, the availability of the soil store of native potassium". He is unable, however, to reach such a definite conclusion in the case of phosphorus. This question will be discussed later in connection with one of our experiments.

In discussing the physical effects of liming on the soil, Lyon and Buckman (1922) remark that "In practice, the amounts of lime applied are generally too small to have much importance in this respect".

The possibility of a shortage of calcium in the general economy of plant growth is receiving more and more attention. We have come to speak of the "lime requirement" of plants, while this term was still recently applied exclusively to soils.

Truog (1918) and MacIntire hold the insufficiency of calcium nutrition largely responsible for the toxicity of acid soils to plants.

Little is known of the physiological functions of calcium. As reported by Thatcher (1921), it is commonly believed that calcium is connected in some way with the development of cell-wall material.

André (1914) states that calcium is involved in the migration of starch.

Gain (1918), after Loew, admits that cium may enter into the composition of tain proteins.

Parker and Truog (1920) suggest tha "Protein metabolism is probably one of chief sources of plant acids and this may rise to the need of calcium in the carbo form for the neutralization of these acid

André points out, with Amar, that plants rather poor in calcium are extre rich in oxalic acid, and that the formatio calcium oxalate crystals, often reporte certain plants, may be intended for the eli ation of an excess of calcium as well a that of an excess of acids.

Newton (1923) shows some evidence "the quantity of calcium absorbed by a p does not necessarily depend upon the q tity of nitrogen absorbed or metabolized.

The indirect role of calcium as a sy getic or antagonistic agent is hardly b understood than its direct physiological f tions.

We have already referred to the calc magnesium ration in the soil. André p out that the assimilation of phophoric is a function of this ratio of calcium to m nesium.

True (1921) found that the calcium make the potassium ions "physiologic available", and that, to a lesser degree, potassium ions help in the absorption of cium ions.

Ehrenberg (1919) shows, on the o hand, that an excess of lime partly prev the assimilation of potash.

Mazé (1913-14) and his associates fo that the same was true for iron and o substances.

The fact that the different elements n sary for plant growth are interdependent the plant as well as in its nutrient medi makes the exact determination of their spective physiological functions exceedi difficult, if not impossible.

The known beneficial effects of lime soils, as seen through the literature on subject, may be summarized in the follo points:

Lime may neutralize an acid reaction d mental to plant growth or to useful soil

ganisms. The plants seem less sensitive to actual acidity than the micro-organisms.

Lime may counteract the effects of toxic elements such as aluminum, manganese, etc.

It may affect the availability of useful elements such as phosphorus and, less likely, potassium.

A large lime application may affect the physical properties of soils.

Lime supplies calcium which is essential to plant growth, and may be deficient in certain soils.

EXPERIMENTAL

Soils Used

The Dunkirk clay loam is a heavy and compact soil which becomes easily puddled, under improper handling.

The soil was obtained from the experimental fields of Cornell University Agricultural Experiment Station. Its chemical composition is given as follows by Lyon and Bizzell (1918).

Table I.—CHEMICAL ANALYSIS OF THE DUNKIRK CLAY LOAM.

Constituents determined	First foot
Nitrogen (per cent)	0.134
Organic carbon (per cent)	1.190
Calcium oxide (per cent)	0.340
Magnesium oxide (per cent)	0.350
Potassium oxide (per cent)	1.830
Sodium oxide (per cent)	0.860
Phosphoric anhydride (per cent)	0.084
Sulphur trioxide (per cent)	0.084
Carbon dioxide (per cent)	0.030
Lime requirement (CaO in parts per million)	1222.
Lime requirement (CaO in pounds per acre foot, according to the Veitch method)	4454.

In the field the Dunkirk soil responds to liming and to fertilizers. The unlimed soil gives a fair crop of red clover, but alfalfa is a failure unless a substantial lime application is made.

The two other soils used have been classified as Volusia silt loam. They were brought from locations a few miles apart, and will be designated accordingly as the "Turkey Hill" and the "Virgil" soil.

The Volusia silt loam is a rather unproductive soil, commonly found on the hill land of southern New York. It was formed from shale and sandstone, and still contains much broken shale. Glaciation was apparently less effective on these high lands. The Volusia is generally poorly drained on account of the compactness of the sub-soil. The chemical analysis (Lyon and Bizzell - 1921) of the Volusia soil from Turkey Hill is given in table 2.

Table II.—CHEMICAL ANALYSIS OF THE VOLUSIA SILT LOAM.

Constituents determined	First foot
Nitrogen (per cent)	0.145
Organic carbon (per cent)	1.560
Calcium oxide (per cent)	0.230
Magnesium oxide (per cent)	0.560
Potassium oxide (per cent)	1.690
Sodium oxide (per cent)	1.120
Phosphoric anhydride (per cent)	0.071
Sulphur trioxide (per cent)	0.042
Carbon dioxide as carbonate (per cent)	0.030
Lime requirement (CaO in parts per million)	1350.

A complete chemical analysis of the Virgil soil was not available, but this soil was found to contain only 0.122 per cent of calcium oxide, and 1.1 per cent of magnesium oxide.

EXPERIMENTS WITH THE DUNKIRK CLAY LOAM

Object

We have seen that alfalfa cannot be grown on the Dunkirk clay loam, unless lime is applied; while it was observed, in previous experiments, that this soil does not respond so markedly to liming under greenhouse conditions.

It was decided to study the effect of a lime application on the yield of alfalfa grown in the greenhouse.

Preparation and Results of the Pot-Cultures.

The soil was placed in three-gallon pots, previously weighed, in amounts equivalent to ten kilos of dry soil per pot. The pots to be treated were emptied into a large container, and calcium carbonate C.P. was thoroughly mixed with the soil, at the rate of 2800 parts per million, which is equivalent to the ap-

plications found to give good results in the field. A lower application of 2000 p.p.m. was also made, to be compared with an equivalent application of barium carbonate intended to check up the basic effect of the calcium carbonate. The treatments were applied in quadruplicates. The moisture was maintained, by frequent weighings, at 30 per cent dry basis.

Alfalfa was sown on the differently treated pots, on August 4th. Crops were harvested on November 6th, March 19th, May 13th, June 23rd, August 7th and September 21st. In August and September, the growth was very slow, and it was decided to discontinue the experiment.

The sum of the average yields per pot is given, for each treatment, in table 3.

Table III.—TOTAL AVERAGE YIELDS OF ALFALFA ON THE DUNKIRK CLAY LOAM.

Treatment	yield in grs.	yield in %
None	75.0	100.00
$CaCO_3$, 2000 p.p.m.	96.0	128.00
$CaCO_3$, 2800 p.p.m.	110.00	146.66
$BaCO_3$, equiv. 2000 p.p.m. $CaCO_3$	52.0	69.33

The barium carbonate treatment proved toxic. We have already pointed out that alfalfa could not be grown on the unlimed Dunkirk soil in the field. The 75 grams obtained, in the greenhouse, per pot of the unlimed soil, are about equivalent to a yield of 7.3 tons to the acre, which can certainly be called a fair yield. This is confirmation of previous observations relative to the action of lime under greenhouse conditions.

Effect of Stirring and Drying

While an explanation of this increased productivity was sought for, it was recalled that the soil used here had been subjected to repeated handling, made necessary for the breaking of the numerous lumps present when the soil was brought in. When the soil was placed in the pots, after three weeks' exposure under the greenhouse, its water content had dropped to 9 per cent.

In an unpublished paper, Silcox (1922) recently reports that the aeration induced by stirring increased nitrification in the Dunkirk clay loam soil. The initial stirring w found to be as effective, in this respect, repeated stirring.

Klein (1915) had previously studied t effects of drying on this same Dunkirk so He found that drying increased plant grow as well as nitrification and general bact ial activity. Although drying increased t total water-soluble material, it had little fect on the available potassium, phospho and calcium.

Russell (1910) reports that sunlight d ing is equivalent to a nitrogenous fertiliz dressing. Russell and Hutchinson (1909-1 attribute the fertilizing action of drying the fact that detrimental organisms call "protozoa" are killed in the process of d ing. The bacterial numbers, together w productivity, were increased after drying, a it was concluded that it is because they fe on useful bacteria that the protozoa a detrimental to plant growth. It has a been suggested that protozoa may not fe on bacteria, but simply compete with th for nutrients.

In order to ascertain whether protoz were involved in the fertilizing action of d ing, in the case of the Dunkirk soil, so fresh soil was brought in from the field, a its water-suspension was examined for p tozoa, under the low power microscope. T suspensions were placed in 1 cc. cells, su as used by Itano and Ray (1918), and phen sulfonaphthalene was used as dye.

No trophic forms of protozoa could detected in this first examination of the fre soil. It should be noted that the soil samp was taken during the dry season, and its mo ture content was certainly below optimum

Two kilos of the soil were then kept s urated with water for two weeks, while a other sample was exposed to sundrying, in half inch layer occasionally stirred up.

As was expected, no trophic protozoa cou be found in the suspension of the soil th had been thoroughly dried. It took also long and patient search to discover the ra trophic forms (ciliates and flagellates, af Whipple, 1918) that could be found in t suspension of the soil that had been ke moist.

Fellers and Allison (1920) report that tive protozoa could be found, and yet

very small numbers, in only two of the numerous New Jersey soils examined. Thus the protozoa are probably not involved in the fertilizing action of drying in the Dunkirk soil.

The increased aeration, consequent upon the considerable handling of the soil necessitated by greenhouse experimentation, is probably responsible, through increased nitrification and general bacterial activity, for the relatively good growth of alfalfa obtained on the unlimed pots. When it is seen that liming also increases nitrification, on the Dunkirk soil, the reason for the lesser response of this soil to lime application under greenhouse conditions, becomes apparent.

Effect of Lime on Nitrification

The largest lime treatment gave an increase in yield of 46 per cent over the unlimed soil. In order to see if part of this beneficial effect was not due to an increase in nitrification, duplicate one-gallon pots containing 3 kilos each of limed or unlimed Dunkirk soil, kept bare, were incubated for six months, at optimum moisture. The nitrates were then determined, according to the colorimetric phenol-disulphonic acid method as outlined in Bulletin No. 31 of the U. S. Bureau of Soils.

An application of 3000 p.p.m. of calcium carbonate was found to have increased the accumulation of nitrates about 46 per cent. The unlimed soil, however, contained as much as 215 parts of NO_3 per million of dry soil. This relatively high nitrate-nitrogen content, together with the deep green color of the alfalfa grown on the unlimed soil, suggests that the beneficial effect of the lime treatment cannot wholly be accounted for by the increased nitrification.

Acidity and Toxicity

In order to ascertain the possibility of the beneficial effect of liming being due to the correction of an unfavorable acid condition, it was decided to determine the reaction of the unlimed soil. Equal volumes of soil and neutral distilled water were placed in 250 cc. bottles, and the mixture was stirred up and allowed to stand for about two hours. Half cc. portions of the clear supernatant liquid were then pipetted out and placed in small white porcelain dishes. Two or three drops of a neutral Brom-Thymol-Blue indicator solution were then added to the soil extracts. The resulting color indicated, in all cases, a pH value of 6.5. Joffe (1920) found that alfalfa made excellent growth in a soil having a similar H-ion concentration.

The acidity of the Dunkirk soil, too low to affect plant growth, is probably also insufficient to permit the existence of soluble toxic substances sometimes found in acid soils.

Effect of Lime on the Solubility of Potassium and Phosphorus

In order to ascertain whether liming had any effect on the solubility of phosphorus and potassium, a 5-1 water extract was made on the limed and unlimed Dunkirk soil incubated during six months for the study of nitrification.

Portions of soil equivalent to 500 grams dry weight were placed in five liter bottles. Water was added up to the proportion 5-1. The mixture was shaken for five minutes and allowed to settle for ten minutes. The suspension was then siphoned out and passed through the Pasteur-Chamberlain filter.

The procedures followed in the determination of phosphorus, potassium and calcium, in the extracts, are those outlined by Stewart (1918). The calcium, however, was found in sufficient amount for a gravimetric determination. For the determination of phosphorus, 400 cc. portions of the extract were used, instead of 200 cc. as proposed by Stewart.

Duplicate determinations were made in every case, which were found to check very closely.

The data obtained are given in table 4.

Table IV.—EFFECT OF LIMING ON THE SOLUBILITY OF PHOSPHORUS, POTASSIUM AND CALCIUM IN THE DUNKIRK CLAY LOAM.

Treatment	P_2O_5	K in extract p.p.m.	K in p.p.m. dry soil	Ca in extract p.p.m.	Ca in p.p.m. dry soil
None	trace	6.72	33.60	22	110
3000 p.p.m. $CaCO_3$	none	7.37	36.85	43	215

There were only traces of water-soluble phosphorus in the extract of the unlimed

Dunkirk soil, and liming has apparently decreased the already very low availability of phosphorus.

Liming has apparently increased slightly the solubility of potassium in this soil. This effect, however, seems insufficient to account for the increased growth obtained through the lime treatment.

Calcium Needed as Nutrient

The calcium carbonate addition has practically doubled the amount of water-soluble calcium present in the Dunkirk soil six months after the treatment.

When one considers the results previously discussed, and the exceptionally high "lime-requirement" of alfalfa, it becomes apparent that the added calcium has played the part of a nutrient in stimulating the growth of alfalfa on the Dunkirk clay loam.

EXPERIMENTS WITH THE VOLUSIA SILT LOAM

In connection with other experiments not reported here, Canada-Field-Peas were grown, on three-gallon pots in the greenhouse, on the two Volusia soils already referred to. The yields obtained are reported diagrammatically in Fig. I.

The total yield on the unlimed Turkey Hil soil was 60 per cent, and the yield of stra 127 per cent larger than on the unlimed Vir gil soil. These results are very suggestive o the lack of calcium in the Virgil soil, when considering that most of the calcium take up by plants remains in the straw, it is re called that this soil contained only 0.122 pe cent of calcium oxide, while the Turkey Hil soil contains 0.23 per cent of the same. How ever, liming gave an increase in yield of onl 35 per cent. on the Virgil soil, while the in crease was 79 per cent on the Turkey Hil soil. It is quite apparent that there was an other limiting factor in the case of the Vir gil soil. Field tests had shown previousl that the Virgil soil responds to phosphati fertilizers.

Objects

The following experiment was devised wit the double intention of obtaining data o the response of the Virgil soil to calciu addition, after the soil had been supplie with all the other necessary plant-nutrients and of throwing some light on the possibl effects of liming on the utilization of phos phorus.

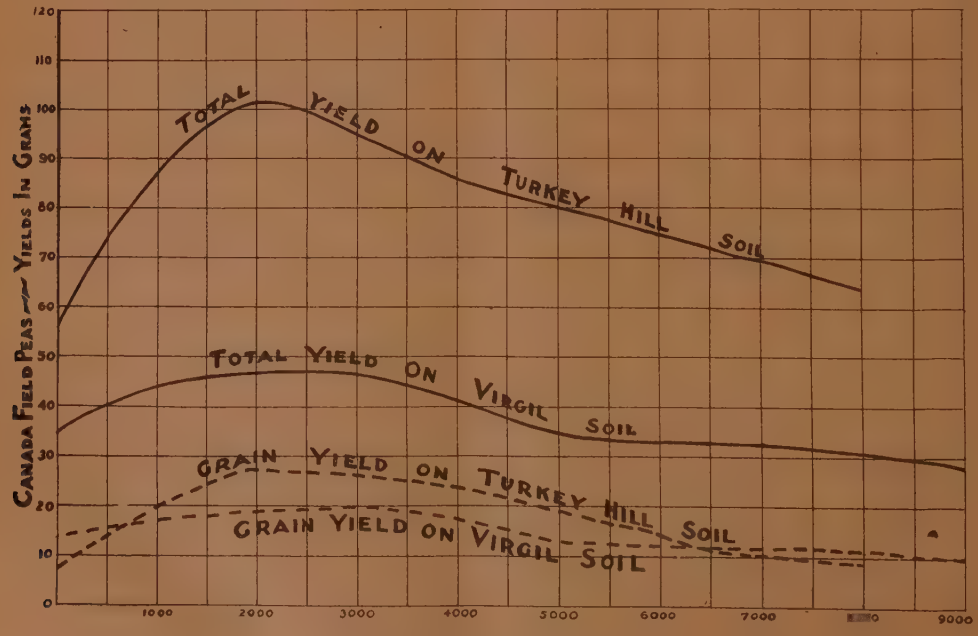

Figure I.

Preparation and Results of Pot-Cultures

Two series of three-gallon pots were filled with the equivalent of ten kilos of the dry Virgil soil. One series received, in triplicates, applications of monobasic sodium phosphate equivalent to one, two, three and four hundred pounds to the acre of Commercial Acid Phosphate containing 7.532 per cent of available elemental phosphorus. The second series received similar phosphorus treatments with the addition of 3000 p.p.m. of calcium carbonate. Two applications of potassium nitrate, in solution, were made on the growing plants.

In order to estimate the respective contribution of the various plant-nutrients entering into the composition of Commercial Acid Phosphate to the total beneficial effect produced by the application of this fertilizer, four additional sets of triplicates were prepared. The first set was treated with the Commercial Acid Phosphate at the rate of 400 lbs. to the acre; a second set received an equivalent amount of phosphorus as monocalcium phosphate. A third set received a small amount of calcium sulphate and carbonate equivalent to the sulphur and the calcium applied as Commercial Acid Phosphate to the first set. Finally, the fourth set received only the small amount of calcium carbonate equivalent to the calcium applied to the first set.

The moisture was kept at 25 per cent of the dry soil. All the pots were sown in clover. There was hardly any growth during the winter months; and on February 21st, when the first application of potassium nitrate was made, the best clover plants were hardly over one inch above the soil. Note was taken of the fact that the stand of clover on the untreated pots, as well as on those having received only phosphorus, was far better than on the limed pots, whether treated or untreated with phosphorus. Exception must be made, however, for those limed pots which had received the highest phosphorus application; the growth in this case being almost as good as on the unlimed pots.

On March 20th, the same abnormality was still more noticeable. Thus far, liming had apparently lowered the availability, not only of the added phosphates, but also of the native phosphates. As Spring came, however, the growth became more and more rapid, and the difference between the limed and unlimed pots soon disappeared. In early June, the difference had shifted in favor of the lime treatments, where the plants were larger and of a more healthy color.

A second application of potassium nitrate had been made in early May, bringing the treatment to 200 parts per million of the dry soil.

When the clover roots were pulled out, after the second crop, it was found that many nodules had developed, even on the unlimed soil.

The first clover crop was cut on June 29th. As the plants had become infected with "red spider", the clover roots were pulled out on few of the pots, and barley was sown on them. The other pots were transported outside of the greenhouse, where a second clover crop was allowed to grow, with the help of occasional watering.

All of the data obtained in this experiment are given in table 5.

As regards the first clover crop, we may say that the phosphate treatment has quadrupled the yield on both the limed and the unlimed pots, while liming has doubled the yield, whether the pots had received phosphoric acid or not. This however does not mean that phosphoric fertilization alone would give better results than liming alone, on the Virgil soil. Indeed, the yield of the first crop suggests that, but the yield of the second clover crop and that of the barley crop just as well indicate that the opposite would be true in the long run.

If we consider the rate of increase in yield with the increasing treatments, as best illustrated in Fig. II, we see that this rate decreases with increasing phosphoric acid applications to the unlimed pots, while it increases with the increasing phosphate treatments on the limed pots. For instance, it is between the 300 and the 400 phosphate treatments that the smallest increase occurs on the unlimed pots; while on the limed pots, it is between the same limits that the greatest increase occurs. This suggests that with larger applications of phosphates, a larger yield would have been obtained on the limed pots.

Table V.—EFFECT OF LIMING AND PHOSPHATIC FERTILIZATION ON THE PRODUC TIVITY AND REACTION OF THE VIRGIL VOLUSIA SILT LOAM.

Treatment	1st Clover crop yield grams	Probable Error (Peter's)	2nd Crop Clover grams	Barley grams	H-ion conc pH
None	4.317	0.33	...	7.93	5.95
NaH_2Po_4 = 100 lbs. Coml. Acid Phos. (per acre)	8.480	0.28	2.33	...	...
" = 200 " " " " " "	11.630	0.133	...	9.66	...
" = 300 " " " " " "	14,900	0.277	2.70	...	...
" = 400 " " " " " "	14.983	0.310	...	10.00	6.0
$CaCO_3$ = 3000 p.p.m.	8.730	0.105	...	14.50	6.4
" = 3000 " + NaH_2PO_4 = 100	13.183	0.403	10.80	...	...
" = 3000 " + " = 200	17.200	0.237	...	12.60	...
" = 3000 " + " = 300	21.870	0.526	15.31	...	...
" = 3000 " + " = 400	32.000	0.476	...	13.46	6.4
Coml. A.P. = 300 lbs. per acre	13.533	0.401	...	7.86	...
$CaH_4(PO_4)_2$ = PO_4 of 300 C.A.P.	11.370	0.360	...	9.63	...
$CaSO_4$ + $CaCO_3$ = S Ca of 300 C.A.P.	5.017	0.202	1.71	...	...
$CaCO_3$ + Ca of 300 C.A.P.	4.033	0.322	1.55	...	...

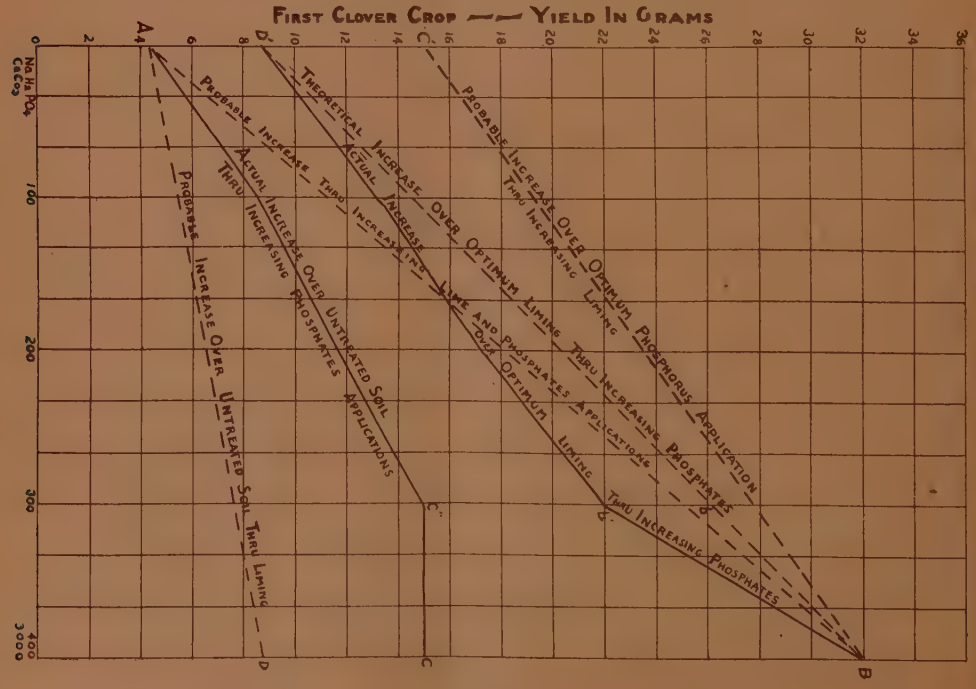

FIGURE II.

Treatments: NaH_2PO_4 and $CaCO_3$

Clover Roots, showing effect of adding calcium carbonate in soil treatment.

It suggests also that the decreasing effectiveness of larger phosphate applications on the unlimed pots is the result of a progressive lime deficiency rather than that of a decreasing efficiency of the added phosphates.

When it is recalled that the Virgil soil contains 9 times more magnesium oxide than calcium oxide, the break in the curve D′b′B (Fig. II) may be accounted for by assuming that the section D′b′ corresponds to the section AC″ raised up by the betterment of an improper Ca/Mg ratio; while the steeper grade of b′B would represent the moment where the added lime, thanks to a sufficient phosphoric acid supply, serves the role of plant nutrient as well as that of antitoxin.

Effect of Liming on Availability of Phosphates

The break in the curve D′b′B, however, is more likely a remnant of the early effect of the lime in decreasing the availability of the phosphates. We have assumed, in drawing the theoretical line D′bB, as well as the others, according to the probable yields that would be obtained between two known quantities, that no other factor intervenes; and that B represents the maximum growth that could be obtained by any combination of phosphorus and lime applications. The case, however, would not be sensibly modified by giving a higher value to B.

One possible intervening factor would be the competition between the calcium carbonate and the loosely combined iron and aluminum compounds or gels for the precipitation of the added phosphates.

According to Truog (1916), Ellett and Hill (1911), Brioux (1922) and others, the precipitated aluminum or iron phosphates have proven more available than the freshly precipitated calcium phosphate, temporarily at least, for a number of plants.

Fraps (1922) and others report cases where liming did not seem to affect the availability of soluble phosphates, and cases where it decreased their intake by plants. Fraps (1917) also states that, "when lime is needed by the soil, it should be applied separately from the fertilizer (phosphatic) and at different times".

Harrison and Das (1921) report that the application of superphosphates is less efficient on the calcareous than on the non-calcareous soils of India.

Truog grew nine different plants on quartz cultures treated with various phosphates.

Seven of the plants gave larger yields on aluminum than on tricalcium phosphates; six grew better on the iron than on the tricalcium phosphate. The iron phosphate even proved better than the acid phosphate in three cases, although it was markedly inferior in four cases.

After consideration of the results obtained by the different authors just referred to, it becomes easier to interpret our own results. As already reported, the addition of calcium carbonate to the Virgil soil treated with a soluble phophate has apparently checked, for at least four months, the beneficial effect of the treatment. It is probable, also, that the depressing effect of the lime treatment on the availability of the phosphate persisted up to the close of the experiment, and that the final increase in yield on the limed pots is to be credited very largely to the physiological need of calcium and to its effects on the root development, (as indicated in the photograph) enabling the plant to make a better use of the added phosphates or potassium, or of the soil supply in these and other nutrients.

The calcium may have fixed a good part of the added phosphates as tricalcium salt, which would be less available than the freshly precipitated aluminum or iron phosphates probably originating from the application of the soluble phosphate to the unlimed soil.

It must be recalled that liming also depressed, at first, the growth of clover on the soil where no phosphate was applied.

Truog reports: "In pot cultures with acid soils needing phosphate fertilization the writer has often observed a decrease in the growth of cereals due to the addition of lime carbonate. This decrease in availability is undoubtedly due to a condition which is temporary. In becoming acid a soil goes into a condition which takes years to develop, and the addition of lime carbonate causes many profound changes, some of which may affect the availability of the phosphorus. The very favorable results obtained by investigators in long continued field experiments involving the use of ground limestone is strong evidence that any unfavorable result at the start is due to temporary conditions".

Gile and Carrero (1923) recently report experiments showing that liming decreased the efficiency of soluble phosphates on f soils, and increased it on others. The fir yields of the millet grown on the pots a taken as the measure of the efficiency of t treatments. The authors give the compo tion of seven of the nine soils used in th experiments. We note that on the two so having the highest lime content liming c creases the availability of acid phosphate well as of other phosphates; while the thr soils where the efficiency of the soluble pho phates was increased by liming are rath low in lime.

It seems hardly conceivable that a ve moderate lime application to an acid soil e ceedingly poor in calcium could create, ev for as short a time as four months, a gener soil condition unfavorable for the growth a lime-loving plant. Under these condition all of the commonly known effects of limi would be beneficial to plant growth. T initial depressing effect of the calcium ca bonate treatment on the Virgil soil shou be rather closely connected with the ava ability of the native phosphorus.

According to Truog, the neutral aluminu and iron phosphates are readily hydrolyze and thus their phosphoric acid may be mo available than that of the tricalcium pho phate. Upon removal of the acidic pa however, the mineral phosphates become mo and more basic and insoluble, which justifi the use of lime on non-calcareous soils whe soluble phosphates are to be applied; t tricalcium phosphate having a better distr buted availability than the iron and aluminu phosphates which, in time, would becom practically unavailable.

According to these views, the native pho phorus of the Virgil soil should be in a ver insoluble form. It will be seen in table that no traces of water-soluble phosphor could be found either in the unlimed or i the limed Virgil soil.

It is not easy to explain how lime coul immediately affect, to any appreciable e tent, the availability of these insoluble pho phorus compounds, except possibly throug the influence of the new reaction developed or better, through the flocculating action o the divalent Ca ions, in modifying their stru ture and especially their surface which migh become less adaptable to the intimate roo

contact necessary for the intake of their phosphoric acid by the plants. In this case the effect would probably extend over a fairly long period.

Comber (1922) points out that the available phosphates have...."a hydrophilous surface with which the root hair can make its attachment...." while "....the unavailable phosphates appear not to have a colloidal surface."

Another possibility would be that lime could, in some way, hinder the aptitude of the plant to feed on the soil phosphates. This detrimental effect could be temporary, lasting only as long as the intake of calcium may exceed the needs of the growing plant for this element. Not much as yet can be said in favor of this interpretation, except that soil scientists generally admit that the different plants possess a distinct so-called "foraging-power" for the various phosphates; which suggests that, apart from its physiological needs, the plant can control, to a certain extent, the assimilation of phosphoric acid, and that anything which affects the plant's system may also influence its "foraging-power".

Bauer and Haas' (1922) data show that liming did not noticeably modify the actual acidity of the root sap of soy-beans. Newton's data suggest that the root juices of leguminous plants have a strong buffer action, and that the pH value of plant sap is not appreciably increased by limiting the plant's supply of calcium. Comber remarks, however, that "the solution of mineral matter by the sap and mucilage of plant cells is not to be regarded as essentially an acid dissolution".

Whatever may be the reason of the depressing effect of liming on the availability of the Virgil soil's phosphorus, it will possibly hold true also for the applied phosphates. It is impossible, indeed, that most of the phosphate added in dilute solution to the limed soil has been absorbed by the soil colloids, just as in the case of the unlimed soil; for the surfaces exposed by the re-agents would be the controlling factor in this case, and the surface of the relatively small amount of calcium carbonate added, however finely subdivided, is but a small fraction of the surface exposed by the soil colloidal particles and films.

André (1921) states, however, that the insolubilization of superphosphates with iron and aluminum oxides, or colloidal silicates, may be slow in acid soils. The addition of lime might then lower their availability in hastening their fixation. According to Schloesing (son), as reported by André (1920), the solubilizing action of carbon dioxide on the phosphates is annihilated when the soil solution is saturated with calcium bicarbonate.

Whatever may be the processes involved, it seems that lime has worked in two opposite directions on the Virgil soil; tending, on the one hand, to increase plant growth by supplying a deficient and essential nutrient, and, on the other hand, to decrease the growth by interfering in some way with the assimilation of another deficient and necessary nutrient, which in our case is phosphorus.

We may then expect that liming will check growth as long as phosphorus is the only limiting factor, but as soon as calcium also becomes a limiting factor, liming will probably favor the growth.

It is obvious, from the first glance at Fig. 2, that both phosphorus and calcium are limiting factors on the Virgil soil, as suggested by the departure of the lines AD and AC from the diagonal AB that should obtain if lime and phosphorus were progressively applied together, in the proper proportion to neutralize their possible interaction or other similar effects. The respective positions of the two lines indicate that the phosphorus fertilization is the most beneficial, if a single application is to be made. As already pointed out, however, liming will probably be, in the long run, more profitable than exclusive phosphorus application.

The reasons for this are already apparent from the previous discussion. As will be seen in table 6, the unlimed Virgil soil contained 65 p.p.m., and the limed soil, 160 p.p.m. of water-soluble calcium, while no measurable amount of water-soluble phosphorus could be found in either soil. The upward capillary movement of the soil water, stimulated through surface evaporation, would probably bring to the surface more calcium than necessary, even on the unlimed soil, to supply the rather limited needs of the undeveloped plants. Phosphorus, however, is scarcely present in the soil solution, and must

be absorbed largely through direct contact of the roots with the phosphorus-carrying minerals or colloidal complexes.

As the root system of the young plants is poorly developed, there is a danger of an early shortage of phosphorus, even if the soil should contain all of the phosphorus necessary for a good growth. This is probably the reason why the application of soluble phosphates has so often been found beneficial to the early development of plant roots, and their use advocated, even on soils not especially deficient in phosphorus, as a means to obtain early ripening.

The results of the treatments, as shown on the photograph, tend to substantiate Noll's (1923) statement that: "The evidence is not conclusive that these effects from phosphate are more pronounced than from the other fertilizer elements where the latter are the limiting factors for crop yields."

Indeed, liming has been, in the long run, far more effective than the phosphate treatment in promoting the development of the clover roots on the Virgil soil.

It becomes easy to understand why the addition of phosphorus seems to have become less effective after the first crop. The lack of lime on the untreated soil, not very apparent at first, due to the limited needs of the young plant and the relatively high solubility of calcium, soon became a limiting factor of primary importance as plant growth progressed, and sensibly checked further development. On the limed pots, on the other hand, the increasing need of phosphorus for larger plant growth was largely met by the increasing root development, multiplying the points of contact with the phosphorus-carrying particles or colloids. In the case of barley, the seed probably contains enough phosphorus to supply the early needs of the rapidly growing seedling, and when the young plant needs phosphorus from outside, the rootlets have already reached a sufficient development to meet this need.

Acidity and Toxicity

In order to ascertain the possibility of the beneficial effect of lime on the Volusia soil being due to the correction of an unfavorable acid reaction, the H-ion concentration was determined on the treated and untreated Virgil soil, according to the procedure already outlined in the case of the Dunkirk soil. The data obtained are given in table 5, column 6.

The unlimed soil had a reaction of pH 6.0. Bryan reports that both alsike and red clovers made a good growth on sand cultures, with Crone's nutrient solution, at pH 6.0. It was already pointed out that nodules developed fairly well even on the plants grown on the unlimed soil. The acidity of the Volusia soil is apparently not sufficient to be detrimental.

As to the presence of toxic elements, Smith (1920) reports that no aluminum, iron or manganese could be found in the water-extracts of the Volusia soil.

Nitrification

The application of potassium nitrate, in the experiment just reported, has probably eliminated largely the nitrogen factor in the estimation of the beneficial effect of the lime treatment. Howeyer, the effect of liming was also determined on the otherwise untreated Virgil soil incubated for six months.

The unlimed soil was found to contain 114 parts NO_3 per million of dry soil; while the application of 3000 p.p.m. calcium carbonate raised the NO_3 content to 211 p.p.m. Thus, the nitrate-nitrogen was rather low in this Virgil soil; and part of the beneficial effect of liming, under field conditions, is probably due to the stimulation of nitrification.

This low nitrate content is most likely correlative with a low organic matter supply. Another sample of Virgil soil, brought from a different spot in the same field, and incubated in the greenhouse without any treatment, was found to contain after a few months, 380 parts of NO_3 per million of dry soil. Moreover, this soil was fairly acid, the reaction being pH 4.9. It should be noted, however, that this sample was rich in organic matter and still contained, before incubation, many partly decomposed and fresh plant roots. It was already pointed out that, according to Noyes and Conner, the nitrifying power of soils varies with the organic matter and total nitrogen content rather than with the soil reaction.

What the Soil-Extracts Suggest

In order to ascertain the possible effect of liming on the solubility of phosphorus and potassium, 5-1 water-extracts of the limed

and unlimed Virgil soil, incubated for six months, were prepared and analysed as described for the Dunkirk soil. The data obtained are given in table 6. The analysis of the Dunkirk extract is also given for comparison.

There was apparently no water-soluble phosphorus in the Virgil soil.

Liming had no noticeable effect on the solubility of the native potassium in this soil.

There was 146 per cent more calcium in the extract of the limed than in that of the unlimed Virgil soil.

The respective productivity of the Dunkirk and Volusia soils seems to be reflected in their extracts. The Dunkirk clay loam is far more productive than the Volusia soils in general. The water-extract of the untreated Dunkirk soil contains 70 per cent more calcium, and 66 per cent more potassium than the extract of the untreated Virgil soil. Moreover, the Dunkirk soil seems to contain some water-soluble phosphorus, while the Virgil soil hardly contains any.

In an attempt to explain the greater productivity of the Dunkirk soil through the quality of its organic matter, Fontaine (1923) grew Lemna Minor (plant feeding very largely on organic matter) on the extracts of the Dunkirk and Volusia (Virgil) soils. The plant gave a slightly better growth on the extract of the Volusia soil.

In an experiment not reported here, it was found that Rye seedlings gave a sensibly better growth on the extract of the Dunkirk than on that of the Volusia soil.

It seems fair to assume that the greater productivity of the Dunkirk clay loam, as compared to that of the Volusia soils, is the result of a better supply of inorganic plant nutrients in general, and mainly calcium.

However, when the respective amounts of the different plant nutrients within the same extract, are compared, the significance of this extract as an indicator of the soil's and plant's needs, may appear questionable, even if phosphorus is taken as a notable exception to the once generally accepted rule that the plant nutrients must be soluble in order to be available. Indeed, the extracts of both the Dunkirk and the Virgil soils contain over three times as much calcium as potassium. The plants, however, will absorb from 3 to 6 times more potassium than calcium. This is very suggestive, especially in the case of the Virgil soil which is so decidedly deficient in calcium.

Comber, in discussing the relation of the root hairs to the soil particles, emphasizes the chemical possibilities, for the benefit of plant nutrition, of their forming a single system, through the union of their respective colloids. According to the same author, Ramann includes potassium among the nutrients that the plant can utilize without their being in solution. Our own data seem to justify Ramann's and Comber's views.

CONCLUSIONS

Liming increases plant growth on the Dunkirk clay loam and the Volusia silt loam.

The repeated handling of the soil is probably responsible, through an increase in nitrification and general bacterial activity, resulting from the increased aeration, for the lesser response of the Dunkirk clay loam to liming, under greenhouse conditions.

It is probable also that the drying of the soil, induced by excessive handling, has an effect on the soil colloids very similar to that of liming.

The Dunkirk clay loam seems unable to supply properly the needs of plants having a high calcium requirement, such as alfalfa.

Table VI.—EFFECT OF LIMING ON THE SOLUBILITY OF PHOSPHORUS, POTASSIUM AND CALCIUM IN THE VIRGIL VOLUSIA SILT LOAM AND THE DUNKIRK CLAY LOAM.

Soil	Treatment	P_2O_5	K in extract p.p.m.	K in p.p.m dry soil	Ca in extract p.p.m.	Ca in p.p.m. dry soil
Volusia S. L.	None	None	4.03	20.13	13	65
Volusia S. L.	3000 p.p.m. $CaCO_3$	None	3.95	19.75	32	160
Dunkirk C. L.	None	Trace	6.72	33.60	22	110
Dunkirk C. L.	3000 p.p.m. $CaCO_3$	None	7.37	36.85	43	215

Liming markedly increases the accumulation of nitrates in the Volusia silt loam, as well as in the Dunkirk clay loam; and this probably accounts for part of the beneficial effect of the treatment.

The Volusia soils do not contain enough calcium to meet the needs of a normal plant growth.

The Volusia soil from Virgil is also deficient in phosphorus.

Liming seems to decrease the availability of phosphorus in both the Volusia (Virgil) and the Dunkirk soils.

Liming seems to increase the solubility of potassium on the Dunkirk soil, but it has no such effect on the Virgil soil.

The amount of calcium in the water-extracts of both soils was about doubled by liming, as measured six months after the treatment.

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Dr. James Mills

In the death of Dr. James Mills at Ottawa, on December 4th, 1924, Canada lost an outstanding figure in the development of agriculture in this country. Although he had been with the Railway Commission for the past 20 years, he was best known for the service he rendered to Canadian agriculture, during a period of 25 years, as President of the Ontario Agricultural College. From that position he resigned in 1904.

To agriculturists in general, but particularly to graduates and ex-students of the O.A.C., his death has removed a friend and counsellor. During his tenure of office at the old college many extensions of its service were effected, new buildings erected and the usefulness of the institution greatly broadened. Many of those who graduated from the O.A.C., between the years 1879 and 1904 now hold positions of great responsibility in the fields of agricultural education and administration, and all will attribute their success, in large measure, to the training they received under the supervision of Dr. Mills.

It was not until last summer that Dr. Mills failed to walk regularly to his office. Just before the holding of the semi-centennial celebrations at the O.A.C., last June, he suffered a shock from which he never fully recovered.

A private funeral service was held at Ottawa on December 6th, and burial took place on the following day. Dr. Mills is survived by one son and five daughters, J. Edgar Mills, Smooth Falls, Ont., Mrs. G. C. Creelman, Beamsville, Ont., Mrs. F. C. Harrison, St. Anne de Bellevue, P.Q., Mrs. H. W. Blaylock, and Mrs. V. M. Drury, both of Montreal, and Mrs. Arthur Hamilton, who has resided with her father at his residence in Ottawa.

A Preliminary Report on Jonathan Breakdown.

P. M. DALY

Central Experimental Farm, Ottawa.

"Jonathan Breakdown" or "Flesh Collapse" is not a new or recently discovered physiological disease of the variety named, since it made its appearance first, in slight degree, as much as fifteen years ago in the fruit growing sections of British Columbia. The extent of the trouble at the time of its appearance did not bring it to general notice. It was not until the season of 1922, when its prevalence was general, that it claimed the attention of the majority of the fruit growers in the inland sections of British Columbia. At that time the loss resulting from it amounted to hundreds of thousands of dollars.

Jonathan breakdown, or internal breakdown, must not be confused with corky core (also known as core rot, brown core or internal browning). While both of these diseases are related, inasmuch as both are physiological and arise through improper methods of growing or time of picking the fruit, they are not in either case actually diseases to the extent of being spread by spores or being an infection which is carried from tree to tree or orchard to orchard. Jonathan breakdown (or flesh collapse) and corky core (core rot, or brown core) are entirely separate troubles both as to cause and as to their effect on the fruit.

Corky core is distinguishable in that, as the name implies, cork-small brownish spots of somewhat dried out tissue, are found within the core area in the Jonathan; in other varieties such as Gano the cork spots are found in the flesh outside the core, as well as in the core area, but are always dark brown in color, are scattered through the flesh and are rarely larger than a quarter of an inch in diameter. Corky core, too, is apparent in the fruit for a considerable period before it is mature on the tree. It seems to be caused by water deficiencies or a disturbed root system, such as would result from ploughing where a surface system of roots has been developed by formation of heavy clover sod in an orchard. It is often accompanied by black-hearting of the wood, and is closely related to drought spot and often follows the appearance of that physiological trouble.

"Jonathan breakdown" ("flesh collapse", or "internal breakdown") on the other hand is seldom, if ever, observed in fruit on the trees. It does not usually develop until after the apples have been picked and the fruit has been held in storage for a least a period. It does not affect mainly the tissue within the core area but also the flesh outside the core. It appears first as light brownish-colored tissue in the flesh of the apple, as seen in Fig. I, extending around outside the core midway between the core and the skin. These light brown areas, in the normal storage period of the variety, later become streaked with darker brown and eventually all the flesh of the fruit becomes affected as seen in Fig. 2, a photograph of breakdown apples examined the last of February. Breakdown is apparently a disintegration of the cell; sections of breakdown tissue as compared with healthy tissue are shown in Fig. 3.

To what can this disintegration be attributed? It may be autolysis, it may be the result of enzyme action upon particular tissues of the apple as soon as a certain degree of maturity is reached, or it may be preceded by the rupturing of the cell walls due to the osmotic pressure set up by the unequal concentration of the sugars of the apple, which we might reasonably expect would accompany the water core observed radiating into the flesh of the apple. It may be due to any of the above, a combination of the latter two agencies, or perhaps it may not be due to any of the above mentioned factors.

To dilate further upon the actual physiological cause of the disintegration found would be but to theorize and add mere words which are little less than conjecture. Solution of the concrete causal factors and conditions would probably constitute a problem covering at least three to five years or even more for a keen investigator who is a cytologist, physiologist and bio-chemist. Because of the attention and expense necessary, if the more

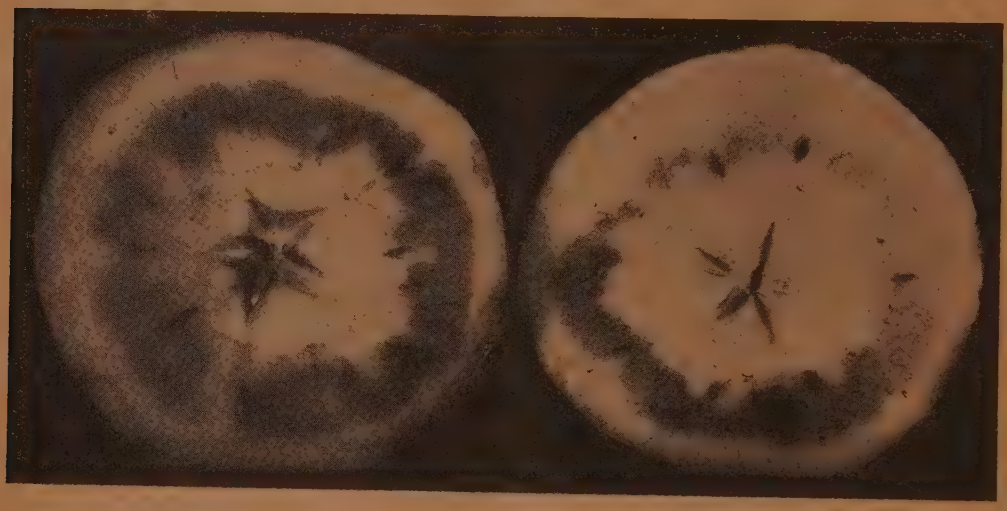


FIGURE I.

Jonathan, showing stage of Breakdown developing by December 18th. The three small dark areas are remaining traces of "Radial Water Core".

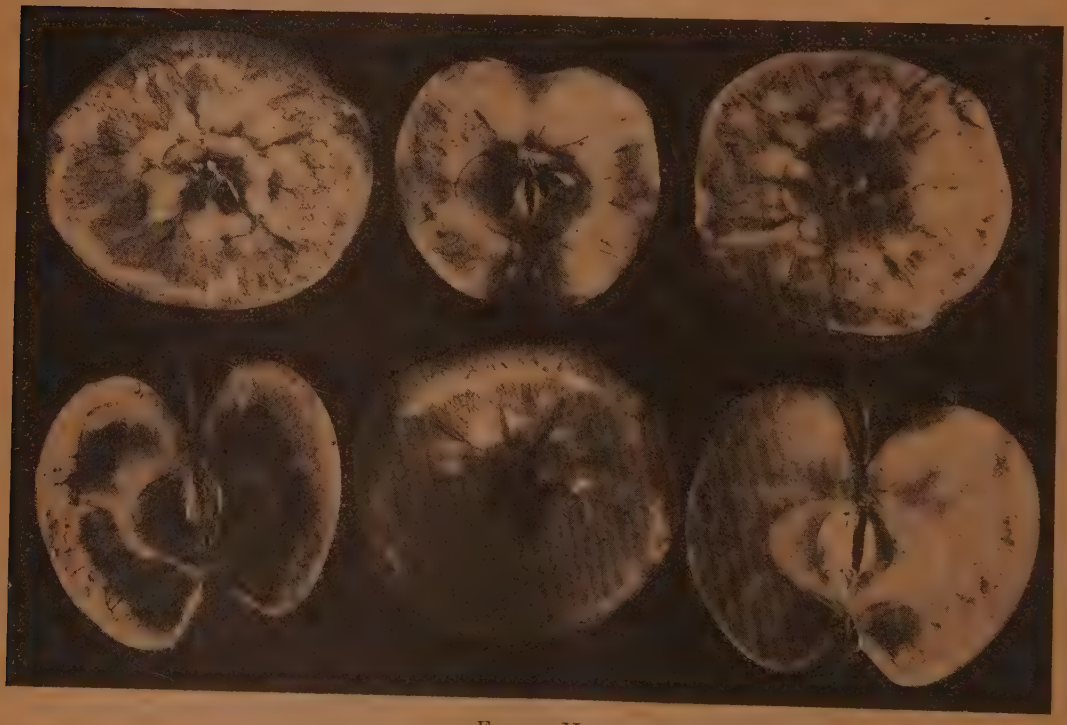


FIGURE II.

Longitudinal and Cross Sections of Jonathan, showing stage of Breakdown developing by February 23. Lower centre apple and upper right hand corner apple still show traces of Radial Water Core, while lower left corner apple shows how Water Core has extended through the tissues.

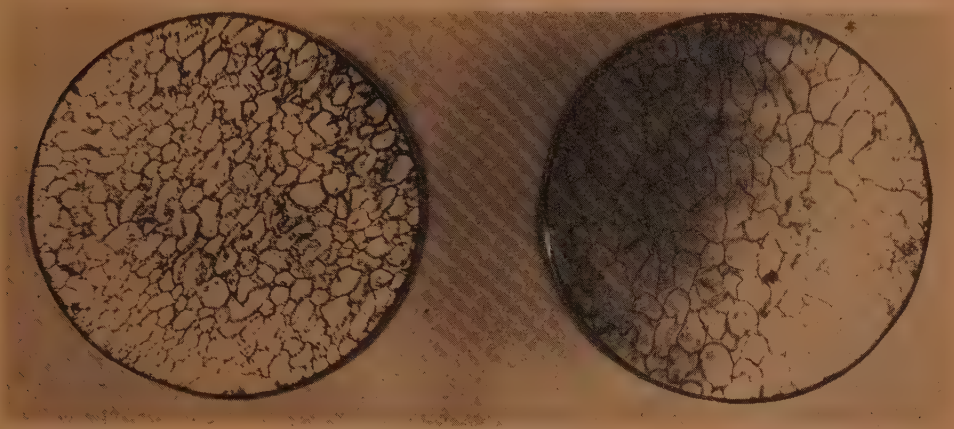


FIGURE III.

Left, Healthy tissue; Right, Broken-down tissue.

delicate phases of it are to be solved, it was decided that the best method of attack, at least for the present, lay along the lines of those factors most readily accessible to investigation.

As a result of the amount of breakdown occurring in 1922 it was decided that some move must be made to discover the underlying causes of the trouble and attempt to bring about some remedy. With this object in view, the Horticultural Division of the Central Experimental Farm at Ottawa drew up a questionnaire in the winter of 1922-23, sending it to some two thousand growers in the Kootenay Valley, Okanagan Valley and the surrounding fruit growing sections of British Columbia. This questionnaire contained questions as to the character of the soil, depth of surface soil, character of subsoil, whether soil was retentive of moisture, whether irrigated regularly or at all, date of first irrigations for 1919, 1920, 1921, 1922, dates of subsequent irrigations for the same years, conditions as regards soil moisture in spring and at freeze-up for the same years, amount of water applied at each irrigation, distance of run of water, duration of each irrigation, how orchard was fertilized, names of varieties affected, description of injury, date when browning first noticed, stage of development of fruit when first noticed, date of picking, percent of crop affected, if stored what percent of injury occurred after storage, what seemed conditions of storage favouring development of injury, (last eight questions covered the four years 1919-1922), and names of varieties not affected.

About four hundred replies were received and among these were many excellent answers. Considerably diverging opinions were expressed as to the causes of the trouble. Many different opinions of the cause were expressed, some attributing it to improper storage, and others to soil and location of trees. The most valuable suggestion brought out by some of the best growers however, was that of the relation of maturity of the fruit to the breakdown and that the trouble arose from leaving the fruit too long on the trees waiting for high color.

On his trip to the branch Farms and Stations, Mr. W. T. Macoun, Dominion Horticulturist, made a trip through the Okanagan Valley, and the expressions from some of the growers he met were largely in confirmation of that gathered from some of the questionnaires, viz., that maturity is closely related to the trouble and that carrying on a picking date experiment for Jonathans would be of considerable service to the grower.

Experimental Methods Followed

An experiment was started early in September, 1923, by the Horticultural Division of the Central Farm, with the assistance of the Dominion Experimental Station at Summerland, B.C., and with the cooperation of the Dominion Fruit Branch as regards much of the transportation from place to place in the

Okanagan and as to the running of the detail of the experiment.

Five orchards were selected, sufficiently apart and well enough scattered through the Okanagan to provide locations fairly representative of the whole valley and yet be acessible enough to permit making pickings twice weekly in each orchard. The points at which orchards were selected were Summerland, Kelowna, Okanagan Centre, Vernon and Salmon Arm.

Trees were selected in pairs in each orchard, adjoining if possible, each tree of the pair as nearly identical as possible to its mate. Six pairs of trees were picked out in each orchard in order to give as great a range as possible as regards kind of soil, location with regard to distance from the flume or ditch, cultural methods practiced, condition of tree and fertilizer treatment. The trees selected were then marked with a string all round the outside and with cotton bags to prevent picking with the general crop; each tree was given a separate number.

Fruit was picked twice weekly from each pair of trees, the apple wraps marked with the number of the tree from which the fruit came and the fruit packed in boxes, thus duplicating current practice as nearly as possible. When pickings were made, both large and small fruit, well colored and undercolored fruit were picked and packed alike in order that each picking might is a good representative sample and to determine, if possible, if color and size have any bearing on breakdown. Each box was numbered with the number of the picking to make possible identification of the actual date on which the fruit was picked. Picking was carried on twice weekly at each point, starting September 17th and concluding October 27th. Picking was carried out over this period in order to start before the regular picking date for this variety and to extend beyond the close of picking for the variety as carried on commercially.

The apples were so packed that each box contained equal quantities of fruit from each of the six pairs of trees in each orchard, and shipments were made in such a way that half of the boxes went to Summerland by boat direct for final storage and the other half went into general storage in the Cement Building of the Kelowna Growers' Exchan Each of these two lots was in duplicate aga except for Salmon Arm and Vernon, in wh case the trees selected did not have sufficie fruit for duplication except for the first fo pickings. One lot from Kelowna Growe Exchange went forward in a general consi ment November 5th to Ottawa arriving th November 17th. A second similar lot w held in the Kelowna Growers' Exchange common air cooled storage until Dec. 19 arriving in Ottawa early in January, thus g ing two different shipping dates and tempe tures, and giving one lot storage at Kelow for a longer period as compared with lon storage at Ottawa. This method of handli afforded a basis of comparison between st age in the Valley till time of consumpti and storage at point of consumption. A cord of humidity kept at Kelowna for month of October showed, according to records of the officials of the Kelowna Gr ers' Exchange, a relative humidity rang from 71 to 88 which is very creditable deed. Thermographs were also placed w the shipments and in the cars through courtesy of the Dominion Fruit Branch a these thermograph charts showed a very f ourable temperature except for a rather cessive rise for a few hours during the per on the boat from Kelowna to Penticton. T storage temperature at Ottawa, where fruit was held in good ordinary stora ranged usually around 38 to 40°F.

When the trees were selected compl notes were taken on condition of tree, size foliage, soil, location, distance from wa supply, cultural methods, fertilizer, whet thinned, etc., and again at the conclusion picking these notes were checked up and ditional notes made on the stage of matu of the trees, etc. When the fruit was pic a number of apples were cut open from e pair of trees and notes made on seed co color of fruit and ground color, amount extent of water core, whether any brown was present at the fibro-vascular bundles presence or absence of physiological troul other than breakdown such as "drought sp or "corky core". The object of keeping s a complete record of the tree was to disco if possible, if any one condition or set of ditions, such as nature of soil, condition tree, amount of water applied, cultural m

ods used, gave breakdown as contrasted with trees where no breakdown occurred. The object of a thorough examination of fruit at picking was to learn if there are any distinguishing characteristics by which it can be discovered beforehand whether fruit will later break down or not. Soil samples were also taken from both the first and second foot of soil under each tree.

The number of boxes of fruit picked was in all 186 of which 93 were shipped to Ottawa and the balance, 88 boxes were stored at Summerland.

As stated previously, picking was commenced on September 17th and continued until October 27th so that fruit was picked twice weekly from each pair of trees of the twelve selected in each orchard, except for Salmon Arm where only three locations were used.

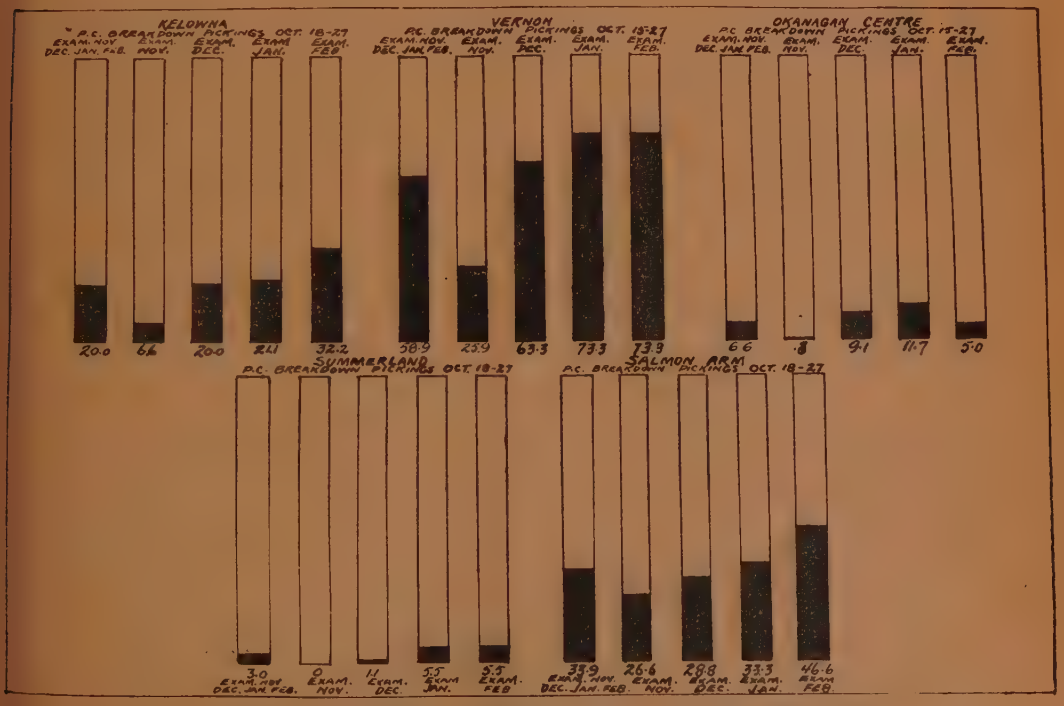
The fruit shipped to Ottawa, in the case of the first shipment, was examined November 21 - 28th, December 17 - 24th, January 16 - 28th and February 22 - 27th, while in the case of the second shipment it was examined twice, January 16 - 28 and February 22nd - 27th.

Notes were taken, when the fruit was examined, on the percentage of breakdown occurring in each picking and the record of each pair of trees in each orchard was kept separately. Whether breakdown had occurred or not was determined by cutting the apples open. Record was also made of the flavour and texture, particularly of the earlier pickings, to determine when picking of the variety can judiciously be commenced without sacrificing quality and flavour.

In all, 51 trees were included in the experiment and from the 96 boxes, 9,360 apples were examined and from these the data given in the summary were compiled.

Results of the Experiment

From the 51 trees used in the experiment 38 trees bore fruit which later broke down and only 13 trees bore fruit absolutely free from breakdown. Of the trees which showed breakdown 26 showed appreciable quantities while



DETAIL OF PERCENTAGE BREAKDOWN FOUND IN LATTER PICKINGS FROM VARIOUS POINTS FOR ALL EXAMINATIONS, AND AS PERIOD OF CONSUMPTION ADVANCED.

FIGURE IV.

SUMMARY

GIVING PERCENTAGE BREAKDOWN FOR DIFFERENT PICKING DATES AND FOR THE VARIOUS EXAMINATIONS, NOVEMBER TO FEBRUARY.

DATE OF EXAMINATION	PICKED SEP. 17-19 No. I	PICKED SEP. 20-22 No. II	PICKED SEP. 24-26 No. III	PICKED SEP. 27-29 No. IV	PICKED OCT. 1-3 No. V	PICKED OCT. 4-6 No. VI	PICKED OCT. 8-10 No. VII	PICKED OCT. 11-13 No. VIII	PICKED OCT. 15-17 No. IX	PICKED OCT. 18-20 No. X	PICKED OCT. 22-24 No. XI	PICKED OCT. 25-27 No. XII	P.C. BREAK-DOWN IN LAST FOUR PICKINGS	TOTAL P.C. IN ALL EXAMINA LAST FOUR PI
NOV. 21-28	NIL	NIL	NIL	NIL	NIL	NIL	.6	NIL	5.3	11.3	9.3	16.6	10.6	22.1
DEC. 17-24	NIL	NIL	NIL	NIL	NIL	NIL	NIL	1.3	12.0	19.3	21.3	34.6	21.8	
JAN. 16-28	NIL	NIL	NIL	NIL	NIL	NIL	NIL	2.0	12.6	21.3	28.6	43.3	26.5	
FEB. 22-27	NIL	NIL	NIL	NIL	NIL	NIL	NIL	3.3	17.3	26.6	26.6	48.0	29.6	

CHECK
(FOR THREE ORCHARDS)

JAN. 16-28	NIL	NIL	NIL	NIL	NIL	NIL	NIL	2.2	6.6	13.3	8.8	25.5	13.6	15.4
FEB. 22-27	NIL	NIL	NIL	NIL	NIL	NIL	NIL	1.1	2.2	12.2	15.5	38.8	17.2	

FIGURE V.

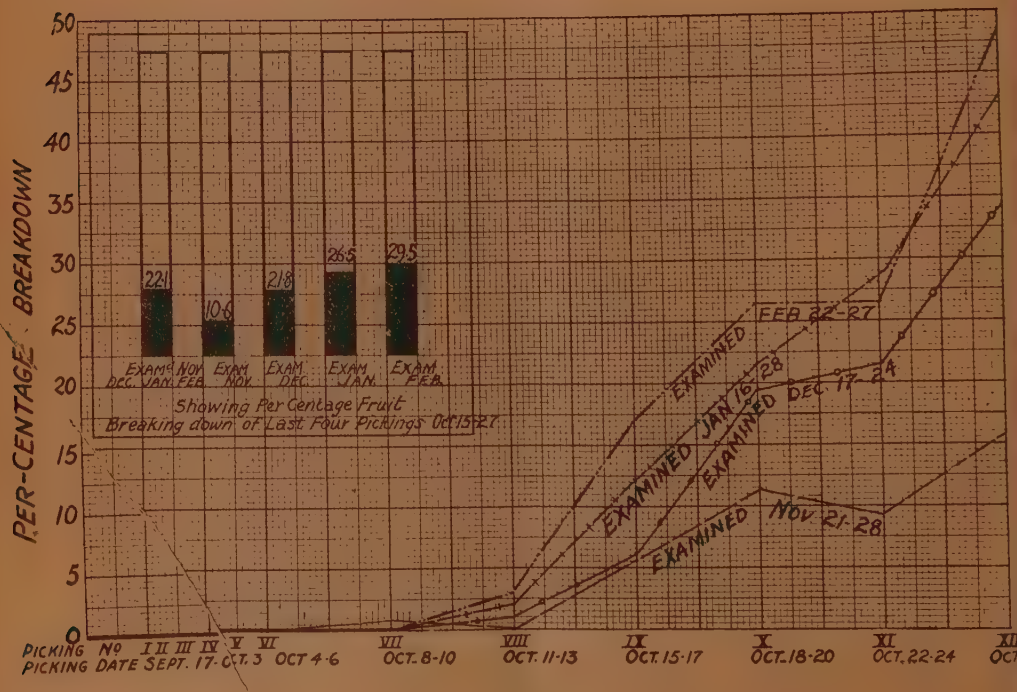


FIGURE VI.

in the other 12 trees breakdown was present only in a very slight degree and was therefore practically negligible.

The detail of trees breaking down is as follows:

	Breaking Down	No Breakdown
Kelowna	10	2
Vernon	11	1
Okanagan Centre	7	5
Summerland	7	5
Salmon Arm	3	0
	38	13

Vernon would have shown all 12 trees breaking down but for the fact that one tree had a particularly light crop and the amount of fruit borne did not admit of carrying out the final pickings on that particular tree.

The outstanding fact shown in both the summary and the graph showing quantity of breakdown found with various picking dates (Figs. 5 and 6 respectively) is that fruit picked prior to October 11th shows only one apple breaking down of the 5,460 examined. Therefore, picking of Jonathans before October 11th in a season such as that of 1923 can be assumed to be perfectly safe as regards breakdown. The amount of breakdown found in the fruit picked October 11 - 13 is slight (only 13 of 780 apples picked during the period October 11 - 13) so that a fairly safe margin of the period of picking, may in fact be said to exist until October 13th in such a season as that of last year.

The fact that only fruit picked after October 11th showed any breakdown whatever is amply borne out by close observation of the fruit actually breaking down. This conclusively proves that maturity is one of the most important factors in breakdown. Only a relatively small proportion of the fruit which broke down was other than the large sized and highly colored fruit. Practically no green, under-colored or undersized fruit whatever broke down, hence this observation entirely supports the conclusion that stage of maturity is the main factor.

Another outstanding fact, in addition to the amount of breakdown appearing in fruit picked on or after October 15th, is the gradual increase in percentage of breakdown found as the date of picking advanced, increasing in the case of the November examined fruit, from 5.3% to 16.6% of all fruit picked on the respective dates October 15 - 17th and October 25 - 27th. In other words, in the fruit examined in November there was an increase of 11.3% in the amount of breakdown, over fruit picked ten days later. It will be seen from the date in the summary (Fig. 5) that the examinations of December, January and February gave a similar increase—from 12.0% to 34.6%, from 12.6% to 43.3% and from 17.3% to 48.0% respectively, as date of picking advanced.

It will also be seen that the total percentage of breakdown in the last four pickings increased, for November examined fruit as compared with December, from 10.6% to 21.8%, from 21.8% to 26.5% for December as compared with January and from 26.5% to 29.6% for January as compared with February. This shows that not only does breakdown occur in the later pickings, but also that it appears in greater quantity as the storage season advances. The ranges of percentage breakdown found, from 12.0% to 34.6% for December examined fruit, from 12.6% to 43.3% for January examined fruit and from 17.3% to 48.0% for the final examination in February show how great this increase in breakdown actually is for later pickings.

It will be seen in the last two columns of the summary (Fig. 5) and in the small chart in the upper left corner of Fig. 6 that 22.1% of fruit picked in the last four pickings, October 15 - 27th, broke down when the various examinations made from November to February inclusive are considered. Not only does this represent a loss of sufficient proportions to render practically valueless Jonathans picked after October 13th, but there is also shown in the same chart and in the last two columns of the summary the increase of from 10.6% breakdown in November to 29.6%, or nearly three times as much breakdown, in the same fruit when stored till the last of February. Hence, it would seem that not only is early picking of this variety essential, preferably not later than October 10th, but when the danger of breakdown is incurred by picking beyond that date, the fruit should be rushed immediately to the consuming market, prefer-

ably in bulk. From the result of this experiment, instead of a 10.6% loss through breakdown, keeping such fruit till well into the season will be seen to entail a much larger loss—several times that quantity and quite sufficient to render fruit practically valueless.

In the chart showing the detail of the later picked fruit from the various orchards where the experiment was carried on (Fig. 4), the same consistent increase of breakdown in storage may be noted. In one orchard only at Okanagan Centre, was there found an actual decrease of the perecent breakdown as the period of consumption advanced and that for only one examination—February. In the other three examinations November to January there is the increase in storage characteristic of the experiment. This increase in storage may be noticed for the Kelowna, Vernon, Summerland and Salmon Arm orchards and is not due to any particular faults of the storage used, since both main lot and check lot showed the same characteristic increase although differently treated as regards place of storage and time of shipment.

As previously stated one lot (from which most of the data are compiled) was shipped November 5th to Ottawa and the second check lot was shipped December 19th. Prior to these dates both lots were held at the Kelowna Growers' Exchange and on arrival at Ottawa both lots were stored under the same storage conditions. The percentage breakdown found in both lots would go to show that there is no advantage in shipping earlier, say in November, over holding in storage at the point where packed until the last of December, and then shipping to point of consumption. The slightly lower percent of breakdown in the check lot has no bearing on the case whatever and would be expected in view of the fact that the data for the check lot do not include any Vernon or Salmon Arm fruit (from which places, in the experiment, much the heaviest breakdown was found).

A fact which is apparent from the chart in Figure 4, showing the percent breakdown somewhat in detail, is the great variation with the various orchards in percent breakdown found. Fruit from the Vernon experiment will be seen to be appreciably far worse affected as regards breakdown than are any of the other orchards, and again that from Salmon Arm showed a much greater percentage than did the other three orchards and is second only to Vernon. Fruit from the Kelowna experiment stands third, with Okanagan Centre next, and Summerland last. The small percentage in Summerland fruit is especially noteworthy being so little as to be almost negligible.

In this connection it may be said that the Summerland experimental results are excellent proof of the fact that the physiological troubles "breakdown" and "corky core" (or "brown core") have absolutely no relation to each other. Breakdown is apparently not preceded by the appearance of corky core or browncore. The latter may be detected early in the season, whereas breakdown is not evident until a few weeks or longer after the fruit is harvested. Of the twelve trees used at Summerland, nine showed a considerable quantity of corky core (or brown core), both at picking and at time of examination, and some of the trees used were also affected with drought spot. None of the other orchards where the experiment was carried on showed any corky core, and were much more seriously affected with breakdown in the late pickings. The Summerland orchard showed comparatively little breakdown, and it is quite reasonable to assume that the underlying disturbed water relations and disturbed nutritional balance which apparently cause corky core, inhibit and decrease the chance of breakdown occurring even in the late pickings. It may also be quite safely assumed that corky core (brown core, core rot, or internal browning) is not in the least related to internal breakdown or flesh collapse as far as the causes of these two physiological diseases are concerned.

Investigations as to the Cause of Breakdown

The thorough and complete notes made on the trees used in the expreiment made possible for reference a record of the condition of each tree used. Not only was this information available as to the condition of the tree but the number of irrigations, cultural methods followed, crop borne, whether thinned, distance from flume, nature of the soil, etc. were also recorded. This record, together

with all recording of fruit when examined by individual trees, enabled the keeping of the record of each tree as an individual to locate, if possible, the cause of breakdown more readily.

The results of this part of the experiment proved entirely negative in that while maturity can be pointed to as the factor of foremost importance, no definite set of conditions can be named as causing the trouble. It occurred in almost equal quantities on non-irrigated fruit at Salmon Arm and on irrigated fruit at Vernon.

A devitalized tree on clean cultivated clay soil ran a heavy percentage of breakdown, whereas a nearby tree under the same conditions and on the same soil similarly cultivated, showed no breakdown whatever. A tree in good condition under clean culture gave no breakdown under test, whereas a tree not sixty feet away in similar condition, and under alfalfa cover cropping, gave a considerable percentage of breakdown. Four trees growing in clover sod all showed some breakdown.

The only tree which did not show breakdown in the Vernon experiment was one on which the crop could not be picked until the conclusion of the experiment, and yet the twelve trees were variously located from 150 to 1000 feet from the main ditch and the amount of water applied must have varied considerably. Not only did the water conditions vary but six trees were located on a bench where the soil was a good loam with plenty of humus, whereas the other six trees were located on a much more gravelly soil. Some of these trees received an application of barnyard manure and others an application of lime, but neither treatment had any effect on the amount of breakdown.

Trees on a splendid soil at Okanagan Centre, in the best of condition, with a heavy alfalfa cover crop, while not showing a heavy percentage breakdown, nor any appreciable quantity till the pickings of October 22nd, nevertheless showed the trouble when picked after the date mentioned. In addition to the condition mentioned, several of these trees received a much heavier application of water, due to seepage, as compared with the twice irrigated trees at Vernon or non-irrigated at Salmon Arm. Several clean cultivated trees at Okanagan Centre did not show breakdown till the very last picking, but this is explained by the highly vegetative nature of these particular trees and the immaturity of fruit which resulted from that condition.

The trees at Summerland were on soils of almost clear sand to a fairly loamy soil, and although these trees were all somewhat devitalized there was exceedingly little difference in the quantity of breakdown, notwithstanding the soil variations and wide differences as regards water availability.

With the above results in mind it will be seen that it is extremely difficult to point out any particular conditions or set of conditions which cause breakdown; where one set of conditions is found under which breakdown occurs in one orchard an entirely different set of conditions prevails in another orchard and even with different trees. According to the work of Ballard, Magness and Hawkins. ("Internal Browning of the Yellow Newtown apple"), in the Pajaro Valley of California. this conclusion is confirmed in that they found adjacent trees giving a distinct variation in the amount of breakdown found. They also found from the records of three seasons' work, that very often a tree which produces sound fruit one year will produce fruit tending to break down badly the next year. This finding would confirm the varied conditions under which breakdown was found to occur in 1923 in the Okanagan Valley.

Another conclusion of Ballard, Magness and Hawkins from their work in the Pajaro section of California, that breakdown cannot be prevented or even noticeably lessened by any one of various fertilizer treatments—nitrogen, manure and phosphorus—is in accord with results found at Vernon, viz., where barnyard manure or lime application was made there was no decrease or prevention of the trouble.

The second finding—that lime applications did not prevent the trouble at Vernon—would tend to dispose of the theory which has been advanced that fruit broke down because of lack of lime. While disproven as far as possible by one year's results, the latter theory also seems rather an illogical conclusion in that apple trees are known to thrive on a

slightly acid soil and are acid tolerant to a considerable degree.

It will be seen then that no particular underlying conditions can at this stage of the work be named as causing breakdown, and that if more definite results are sought as regards the underlying cause of breakdown further investigations must be conducted. Apparently, too, no fertilizer treatment will prevent the trouble, nor can it be known, if a tree produces fruit breaking down one year, what result may be expected in the fruit the following year. In this particular it may be stated that two of the three trees selected in 1923 at Salmon Arm showed breakdown in 1922, while in 1923 all three trees, including the one tree which did not show breakdown in 1922, produced fruit breaking down in considerable quantities in the later pickings.

With regard to the large quantity of breakdown, unprecedented in the history of the Okanagan, occurring in 1922, the impression gathered from some of the fruit growers that the trouble in that year was largely seasonal seems to be confirmed by fact. Since the experimental work done in 1923 appears to fix the trouble as practically entirely due to the stage of maturity at which the fruit was picked, this finding can be linked with the somewhat unusual weather conditions prevailing during the season of 1922, and to these two causes the exceptional amount and widespread prevalence of breakdown that season can be largely attributed.

Copies of the official weather records for May to October inclusive, for 1922 and 1923, were obtained, through the kindness of Messrs. Johnson and Madden of Summerland and Vernon respectively, and a close examination and comparison of these was made in order to discover the outstanding differences between the two years, 1922 and 1923, which would account for the earlier maturity of the fruit the season of 1922.

The season of 1922 was an exceptionally dry one, and all seasonal factors until September tended to mature fruit early. At that period many growers left their fruit to colour, and thus the fruit remained on the trees until about the usual time of picking, although maturing earlier than usual due to these exceptional conditions. That unusual weather conditions existed during the season of 1922 is substantiated by the weather records for that year. The precipitation from May to August was not a third of that f 1923 for the same period, and this dry weat er would tend to bring on maturity earli than usual. The hours of sunshine, too, we materially more in 1922 when the record the season as a whole is compared with 192 Hence, it will be seen that exceptional weath conditions caused earlier maturity than usua while the picking season was not advanc at all correspondingly, and it is more th likely that these factors may be held large responsible for the amount of breakdown 1922.

CONCLUSIONS

Although as varied conditions as possib were chosen for the trees used as regards di tances from irrigation, number of irrigatio fertilizer, cultural methods, tree conditio age of tree, etc., there is as yet no defini conclusion possible that any one conditi or set of conditions is largely responsib for breakdown in the Jonathan. Clean c tivated trees with two irrigations gave a rel tively much greater quantity of breakdow appearing earlier, than did vigorous tre which were more frequently irrigated a cover-cropped with alfalfa. This howeve is only the result of one season's work, a further work would have to be done befo this conclusion, viz., that alfalfa cover cro ping and regular irrigation decrease t amount of breakdown, can be confirmed.

The primary conclusion, and the outstan ing one possible from the results so far, that maturity is the main factor in the preve tion of the trouble, and Jonathans must picked prior to Oct. 10 - 12 in such a seas as that of 1923. The date before which pic ing must be concluded may be advanced an abnormal season such as that of 1922. B such a season as 1922 occurs rarely, say on in eight to ten years, and by close observ tion of the stage of maturity of the fruit ev in such a season the danger from breakdo may be largely averted.

When Jonathans Should be Picked

From the data here given, Oct. 10 - 12 about the last date on which Jonathans c normally be picked. The earlier pickings (fr Sept. 17 to 24 or 27) are somewhat too e ly, and fruit picked between these dates w not only lacking in requisite colour and fla our but shrivelled badly before the peri of consumption was over.

Any time between Sept. 24 or Sept. 27 and Oct. 12 that sufficient colour can be secured s, then, the best time in a normal season to ick this variety. Seeds should not be ust changing from white to a light brown r even a medium brown colour; they should e showing considerable dark brown, or, at east, a moderately dark brown.

One indication that fruit should be picked s found in the primary vascular bundles. Just utside the well defined core area are small lots, usually ten in number, normally of a nore greenish colour than the surrounding issue. These dots or bundles turn yellowish o brown in many cases where the fruit later reaks down. While these bundles often turn rown and yet the fruit does not break down, heir appearance is apparently so closely link- d with the maturity of the fruit that when hey turn brownish fruit should invariably be icked.

A condition even more closely associated vith breakdown and also an indicator of when ruit should be picked is also found when vater core, usually bounded by the core area, tarts to extend into the flesh of the apple or rea outside the core. When this occurs the vater core is in somewhat oval areas, small t first, extending radially all round the core. This condition does not appear until the fruit s sufficiently mature to pick, hence as soon s it develops fruit should be picked as rap- dly as possible. The slightest extending of vater core in clearly defined areas radially rom the core into the flesh of the apple sig- alizes danger in picking beyond that date if reakdown is to be avoided. There would eem to be definite relation between this rad- al water core and breakdown, but what the xact relation is can only be determined by urther observation and by physiological and ytological study of the actual tissue concern- d.

Because of the characteristics mentioned bove, which must be observed as indications f maturity, viz., browning of the bundles and he appearance of radial water core, these in- licators, together with colour, ground colour, nd seed colour, may be used in determining hen Jonathans should be picked.

Seed colour, as stated previously, must be noderately dark brown. Colour should be olid and should extend over a good propor- ion, 25% to 50%, of the whole surface of the ruit, and finally, the ground or under colour should be at least changing from a solid green to somewhat yellowish or showing considerable yellow.

If the grower watches closely for these evidences of a fair state of maturity and yet picks before there is the slightest trace of brown bundles around the core or before water core extending into the flesh makes its appearance, prior to Oct. 10 - 12, there is no reason why the amount of breakdown subsequently developing in Jonathans cannot be reduced to a negligible minimum and eventually be entirely eliminated.

It must not be thought, however, that Oct. 10 - 12 is a fixed date until which picking can be safely carried on every year, because, although last year was apparently nearly normal as to the date of maturity of fruit, much hot dry weather, much dull wet weather, or other abnormal weather conditions may either advance or retard the date of maturity for Jonathans. Hence, in such a case it will be seen that the date given above is purely an approximate one, and determination of the date of maturity in an abnormal season, such as, for instance, that of 1922, when Jonathans apparently matured earlier than usual, must depend on the good judgment of the growers.

While a hot dry growing season might advance the final date of picking, or a dull wet growing season retard maturity, from the data secured in the experiment carried on in the fall and winter of 1923-1924 it appears that shortly before the middle of October in an ordinary season is the latest date that growers should attempt to pick Jonathans. Picking beyond this date is liable not only to diminish the individual grower's returns, due to the inclusion in his pack of fruit that is bound to break down, but will also injure the name of the variety for his own pool or co-operative association and even for growers of the variety in other sections of the Okanagan and Kootenay Valleys.

Since Jonathans comprise 25 to 30% of all trees planted in the Okanagan and since the variety is normally a popular one with the Canadian and Overseas consumer, picking at the right time is well worth while in order to preserve the good name of this variety and to secure the greatest return possible for the growers on their heavy investment in bearing Jonathans and land planted to this variety.

L'Ultramicroscopie Simplifiée

OMER CARON

Botaniste, Ministère de l'Agriculture, Québec.

On observe généralement les objets au microscope en les interposant devant la lumière. Ils nous apparaissent alors soit opaques, soit simplement colorés sur un fond brillant. Il ne faudrait pas croire que nous avons saisi tous les détails d'une préparation en la regardant de cette manière. Le but de cet article est de démontrer que l'on peut, avec un accessoire que ne coûte rien, produire un éclairage à fond noir sur tous les instruments qui possèdent un condensateur.

Lorsqu'au lieu de faire arriver la lumière dans la direction de l'axe optique du microscope, on la dirige de manière à ce qu'elle éclaire l'objet obliquement par rapport à cet axe, les objets que l'on met sur la platine changent totalement d'aspect parce qu'au lieu d'intercepter simplement la lumière, ils nous apparaissent illuminés sur un fond obscur. Dans le cas supposé, l'éclairage devenu très faible ne serait pas toujours utilisable en pratique et les constructeurs d'instruments d'optique ont fourni des accessoires permettant d'utiliser le plus de lumière oblique possible et de la concentrer sur l'objet en observation. Ces accessoires peuvent être, soit des condensateurs paraboliques ou simplement toriques, soit des condensateurs munis d'un écran central ne permettant qu'aux rayons extérieurs du cône de lumière d'arriver à l'objet. Cet éclairage porte la qualification d'"ultramicroscopique" parce qu'il permet de résoudre un grand nombre de détails invisibles en lumière interceptée.

L'ultramicroscopie moderne a permis la solution d'un grand nombre de problèmes en biologie; c'est elle qui a rendu possible la cinématographie microscopique et tout récemment, le professeur F. Lloyd de l'Université McGill s'en servit pour observer la fluorescence de la chlorophylle dans les cellules vivantes, chose réputée impossible jusque là.

Les accessoires fournis par les constructeurs de microscopes donnent d'excellents résultats. Ils ont généralement le défaut d'être très dispendieux et nécessitent un ajustage long et délicat auquel l'observateur ne veut pas ou ne peut pas toujours s'astreindre. Cependant, s'il s'était donné la peine de recourir à l'éclairage microscopique, il aurait pu mieux voir la forme d'une cellule, surpris la formation d'un cristal, découvert un pigment ou trouvé la composition physique d'un liquide.

Il est possible, avons-nous dit, de transformer un condensateur ordinaire en appareil ultramicroscopique. Il suffit pour cela de placer en dessous de la lentille inférieure du condensateur un écran central de forme circulaire. Cet écran permettra aux rayons latéraux du condensateur d'arriver à l'objet mais empêchera les rayons centraux d'eclairer l'objet. Ces derniers ne pourront pas non plus pénétrer dans l'objectif ordinaire s'il est faible.

Certains constructeurs ménagent une glissière en dessous du condensateur du microscope pour y introduire un petit écran de métal noirci. Quand le porte-condensateur ne porte pas de glissière ou que l'on a pas sous la main le condensateur en question, il est facile d'en fabriquer un soi-même qui ne coûtera pas un sou et donnera le même résultat.

Il suffit de prendre un disque de carton de même diamètre que la lentille inférieure du condensateur et de découper trois croissants de manière à ce que la partie centrale reste fixée au pourtour par trois bandes radiales. On noircit le carton qui peut ensuite servir à donner un éclairage ultramicroscopique avec les objectifs faibles. La gravure ci-contre réprésente la forme de l'écran une fois terminé.

Ecran central.

Cet accessoire ne peut servir convenablement qu'avec les objectifs faibles. Avec les objectifs forts, il pourrait encore servir si l'on se servait d'un condensateur achromatique, mais dans le cas d'un condensateur ordinaire, l'irisation provoquée par l'aberration des rayons extérieurs rend l'observation insupportable. Elle peut cependant rendre des services en certains cas où il est nécessaire d'observer avec une lumière très oblique; nous avons pu voir très nettement non seulement les stries mais même les ponctuations du "Pleurosigma angulatum" avec un grossissement de 340 diamètres seulement.

Avec les objectifs forts, on n'obtient pas l'obscurité du champ sans employer un diaphragme dans l'objectif même mais alors, il faudrait changer de lumière et cela ne corrigerait pas les aberrations du condensateur. En ne faisant des observations qu'avec des objectifs faibles, il est possible d'observer un grand nombre de détails intéressants dans la structure des objets. Il est peut-être inutile d'ajouter qu'il faut interposer une goutte d'eau ou d'huile de cèdre entre la surface du condensateur et la lame porte-objet quand on observe avec l'éclairage ultramicroscopique; sans cette précaution, l'illumination serait incomplète et partant défavorable.

Avant d'ecrire cet article nous avons examiné environ deux cents préparations, prises dans les différentes parties de notre collection et en sommes venus aux conclusions suivantes.

CONCLUSIONS

Utilisation de l'écran central pour produire l'éclairage ultramicroscopique simplifié.

1) L'écran central n'est d'aucune utilité pour l'examen des préparations histologiques animales ou végétales colorées.

2) Il peut rendre de grands services pour l'examen des préparations temporaires translucides ou hyalines.

3) Il permet de nous rendre compte de la forme exacte de plusieurs cristaux difficilement observables en lumière ordinaire.

4) Il montre avec précision les dessins des petites graines ainsi que les diodanges (sporanges) des cryptogames à racines.

5) Les particules du sol sont très intéressantes avec cette lumière parce qu'elles sont observées par réflexion.

6) Les fibres textiles méritent d'être observées avec cette lumière quand il s'agit de l'analyse physique.

7) Il permet encore de voir dans les substances organiques plusieurs pigments intéressants, difficilement observables avec la lumière ordinaire.

Concerning the C.S.T.A.

EDITORIAL POLICY

There has always been considerable difference of opinion as to the type of reading matter that should be published in *Scientific Agriculture*. Those members of the Society who are engaged in research and experimental work have been more frequent contributors to the magazine than members carrying on extension work or engaged in teaching and administration. As a consequence, the majority of articles have been more or less technical in nature, whereas the majority of the membership body are perhaps more interested in a more practical type of article. This has resulted in considerable criticism, and to meet this an effort is now being made to make the magazine somewhat more popular in nature, but at the same time to continue the publication of a reasonable amount of technical material.

One section of the magazine which can be considerably extended is that referring to the activities of members and branches of the Society and to such other topics as are of special interest to C.S.T.A. members. Since *Scientific Agriculture* is the official organ of the C.S.T.A., it is important that it should function as such, and serve as a direct connecting link between the central office and the membership body. To assist in effecting this extension, local secretaries are urged to send to the General Secretary, prompt report of all meetings held, together with such other news items as may be worthy of publication. Individual members should send notices of changes of address or position, or other news of a similar nature.

C.S.T.A. Forum

There are many subjects of professional interest which might well be aired and discussed through the columns of *Scientific Agriculture*, and it has been suggested that a certain amount of space should be provided in each issue for the publication of correspondence dealing with such subjects. Letters could be published with or without the correspondents' names, and provided the subject was of general interest, this should result the publication of considerable valuab material, which would increase interest the magazine.

In the February issue under the headir of "Duplication" the question of overlappir of work done by agricultural agencies Canada will be dealt with in this new sectic of the magazine. Members who have ar opinions to express, through this channel, their fellow-workers, on this or any oth subject, are requested to address same to t General Secretary, and also to state wheth they wish to have their names published.

AFFILIATION WITH R.S.C.

The C.S.T.A. has recently been admitte to affiliation with the Royal Society of Ca ada.

APPLICATIONS FOR MEMEBERSHIP

The following applications for membersh were received during the month of Decembe

D. L. Bailey (Queen's 1918, B.S.; Minnesot 1921, M.Sc., Minnesota, 1924, Ph.D.) Agr cultural College, Winnipeg, Man.

A. Blackstock, (Manitoba 1913, B.S.A.) Ga livan, Sask.

R. Broadfoot, (Manitoba, 1923, B.S.A.) Agr cultural College, Winnipeg, Man.

C. McK. Collins (McGill, 1922, B.S.A.) Po Williams, N.S.

A. Desautels, (Laval, 1917, B.A., 192 B.S.A.) 20 Laurier Ave., Quebec, P.Q.

H. H. LeDrew (Toronto, 1905 B.S.A.) O.A.C Guelph, Ont.

T. F. Paterson, (Toronto, 1896, B.S.A.) 110 Haro St., Vancouver, B.C.

W. H. Perron (McGill, 1923, B.S.A.) 344 Park Ave., Montreal, P.Q.

E. J. Rigby (Manitoba, 1923, B.S.A.) Hea ingley, Man.

N. Stansfield (Toronto, 1914, B.S.A.) 24 Summer St., Boston, Mass.

D. G. Will (Manitoba, 1922, B.S.A.) Lorli Sask.

Agricultural Re-organization in Russia*

(Grain and Special Cultures)

D. P. PAVLOV

gricultural Specialist of the Official Agency of the Union of Social Soviet Republics (Russia).

he Union of Social Soviet Republics was eloped from territories of the Old Russian pire, with the exception of Finland, Es- nia, Latvia, Lithuania, and Poland, which e been declared independent republics. area of the former Russian Empire was 55,000 sq. versts (8,417,118 sq. miles) a population in 1915 of 182 millions. territories of these independant repub- total 710,000 sq. versts (399,117 sq. es) with a total population of 29 millions. ollows therefore, that the total area of the .S.R. is 18,445,000 sq. versts (or 8,018,000 miles). The total population of the Un- from the Census of 1920, was 131 mil- s, of which the rural population was 110 lions and the urban population 21 mil- s.

he territory of the Union, located on two tinents, represents a little less than one nth of the total land surface of the globe. m West to East the Union is 6,000 miles and from North to South 1200 miles ad. It is evident that with such a large face the natural conditions of the U.S.R.R. rich in variety, and to a great extent are ilar to conditions in Canada.

he far northern portions of the territory the U.S.S.R. are covered with tundra. ther South is a broad belt of rich coni- us forests, below which, in turn, is a of mixed forest land, and further south n is a belt of broad leaved forest land. o the South of these forests are located grassy steppes which include the famous k Lands. Further South again is a belt ub-tropical vegetation, where the higher les of such sub-tropical plants as grapevine, tobacco, cotton, rice and tea grown.

n general the climate of the U.S.S.R. may described as continental. The principal racteristics are a cold winter and a hot mer, sudden changes in temperature after nightfall, and very little dampness. If we compare the mean temperatures of one of the central cities of the U.S.S.R. Orenburg, (52°N Lat. 55°E. Long.) located on the boundary between Europe and Asia with the mean temperature in Winnipeg, (50° N. Lat. 97° W. Long.) then we obtain the following picture.

	Mean Temperature in January	Mean Temperature in July	Mean Variation of of Temperature
Orenburg	–2.8°F	79.0°F	81.8°
Winnipeg	–3.5°F	66.2°F	69.7°

This is the temperature of one of the central cities, located far from the sea-coast. In localities nearer the coasts, the same as in Canada, a milder climate is found, with a smaller variation of temperature, and in such regions as Turkestan, the climate is still more continental, with very high summer temperatures.

The average rainfall in the territories of the U.S.S.R. is not great, being about 17 to 18 inches per annum, and is distributed most unequally. In the North West the rainfall averages 20 to 24 inches, in the Black Lands 12 to 16 inches, and on the coasts of the Caspian Sea only from 8 to 10 inches per annum.

As regards the characteristics of the soil there is also a very great variation. In the North are found swampy tundras, with an inconsiderable quantity of small oases suitable for cultivation. To the south of the tundras, the forest top-soil, with a layer of quartz sand of various thicknesses, contains an average of 2% of organic matter (humus). Further south are found the great forest soils, forming an intermediate bank to the Black

* Read before a meeting of the Eastern Ontario Branch of the Canadian Society of Technical Agriculturists, Ottawa, December 5, 1924.

Lands. Beyond these are the Black Lands, with a content of organic matter which in some parts reaches 16%. These are the richest soils in the U.S.S.R.. Their area in the European territories of the Union is about 100,000,000 dessiatines (about 300,000,000 acres). There is also a great area of black soil in Asia, (Western Siberia, Altai, and elsewhere) where the total area is almost as great as in the European territory. To the South of the Blacklands the characteristics of the soils are various, (less) saline, chestnut, brown and others. With the exception of the saline lands they are all most suitable for agricultural production.

The duration of the period for vegetation for agricultural plants, varies greatly for different regions of the Union. If we take as a basis for comparison such grains as barley and rye the growth of which is possible with an average temperature of 45°F, then in various regions the number of days of vegetation per annum may be shown as follows:

Northern Region (Archangel)	125 days
Temperate Region (Moscow)	165 days
Blacklands (Voronezh & Kieff)	180-200 "
Southern Region (The Crimea and others)	280-290 "

Consequently, in the Northern parts of the Union, near Archangel, the production of only such crops as rye, oats, barley and potatoes is possible, and then only of the early ripening varieties. The further South one goes, the more variation in production is found, until in the furthest south one finds such heat loving plants as the grapevine, rice, cotton, tea and others.

Of all the territory of the Union, totaling 18,445,000 square versts (8,018,000 square miles) about 40% is covered with forests, about 20% occupied with unproductive lands (tundra, sands etc.) and the balance of 40% are suitable for immediate agricultural development. In addition, depending upon the growth of population, and the development of agricultural methods, one half of the forest lands can be converted to agricultural purposes. It follows, then, that 60% of the total area of the U.S.S.R. may be made suitable for agricultural purposes, that is 1,150,000,000 dessiatines or 3,450,000,000 acres.

Before the Revolutions of 1917-1918 the land in Russia was individually owned. In European Russia the land was owned as lows:

State owned	34
Large land owners	25
Peasant common land	35
Personal Property of the Imperial Family, Church owned lands, etc.	4

In Siberia about 150 million dessiat (450 million acres) were allotted to peas and Russian European emigrants and remaining territories, with the exceptio municipal lands and lands of the Imp family, were the State fund, and these the overwhelming majority.

From these figures it is evident tha European Russia only one third of the was in the hands of the peasantry and f this total there was only about 60 to 65% able for agriculture. Consequently, notw standing the great area of Russia as a wh the amount of land owned individually the peasants, who formed 80% of the t population, was comparatively very sm and this necessitated the peasants leasing from the large landowners and from State, paying enormous rents.

The revolution caused a great change the allotment of land, because the prop of the State, and 96-97% of all suitable a cultural lands were concentrated in the ha of the peasants as users. The other 3 were retained by the State, for the organ tion on these lands of State Agricultural dertakings, experimental stations, seed stock selection farms.

The revolution also caused great cha in the methods of the use of the land by peasantry. Before the revolution the majority of the peasants farmed the c munal land allotment in widely separ holdings. After the reform of 1906 a sm part of the peasants consolidated their se ate holdings and also lived on them ins of living in the villages. The farming widely separated allotments of commu land by one peasant, as the routine an relic of the past, was condemned by revolution. By the new land laws the sant is given the choice of every metho using the land, including the consolidatio several separated holdings into two or m larger holdings, consolidating their hold into one holding, living on his holding

ead of in the village, and various methods collective farming (co-operative farms, mmunes, and co-operative farming of in-vidual holdings.) The Government is sup-orting all the new methods, particularly voring those which call for the greater de-lopment and intensification of farming prac-es. The re-organization of new methods land holding is taking place on a large ale, and calls for a great expenditure of oney by the state and by local authorities, nd necessitates an army of surveyors. Steps e being taken to introduce into general use e best contemporary methods of land divi-on and allotment of which the best example North America and particularly Canada. uring the past year, Prof. Dahoff was sent Canada by the Government of the U.S.S.R. r the purpose of studying your methods of eodetic surveying, on the spot.

Such, in brief, are the general agricultural nditions of the U.S.S.R. During the seven ears from 1914 to 1921, the country has assed through very great historical events, hich have been very heavily reflected on griculture. The disintegration of agricul-re started a year after the commencement f the European war, when all men from 18 42 were called to the colors. The burden f farming the land was principally on the omen. By the beginning of 1917, the war ad so far disorganized the farms, that the rst revolutionary outbreaks were in many ases connected with food shortages. After ne withdrawal of the U.S.S.R. from the uropean war, the no less burdensome civil ar began, with constant foreign interven-on and blockade. During both wars, agri-ulture continued to fall off. Only after 1921, with the return of the country to a peacetime footing, did agriculture begin to be re-established. This process is far from being completed, but taking into considera-tion the rapid change for the better, one can say with certainty that the prime is not far off.

Grain Farming of the U.S.S.R.

Of the food grains, spring and winter rye, spring and winter wheat, oats, barley, buck-wheat, millet and maize are widely cultivated in the U.S.S.R. The sown area, during the decade, 1913-1922, under each crop is indicat-ed below in thousand dessiatines, (one dessia-tine equalling 2.7 acres.)

Such is the movement in the sown area in the U.S.S.R. beginning from 1913. In 1913, 215 million acres were sown in grain, which was the largest area sown during the last ten years. This year has been taken as 100%. In 1916, in consequence of the war, the sown area fell to 90.7%, in 1920 to 71.%, and finally in 1922, as a result of both the Euro-pean and civil wars, and of the enormous crop failure during 1921, which completely broke up peasant agriculture in 30 Provin-ces, the sown area fell off to 54.6% of the pre-war area. This was the year with the smallest sown area, but this year also proved to be the turning point as with the termina-tion of the civil war, with foreign interven-tion and blockade, the country was able to engage in peaceful reconstruction and the re-organization of its economy. The follow-ing year, 1923, the sown area increased to 64.9% of the pre-war area, and this year, 1924, to 82.4%. The increase in sown area has not yet stopped, and next year, 1925, it

Sown Area in Thousands of Dessiatines.

Crop	1913	1916	1920	1922	1923	1924
Rye—winter	22,902	20,485	16,304	16,574	20,069	20,150
Rye—Spring	560	575	352	190	198	220
Wheat—winter	5,342	5,823	3,782	3,129	3,217	4,140
Wheat—spring	20,782	17,180	13,479	5,108	7,380	14,320
Oats	15,137	14,081	10,342	6,613	8,098	13,260
Barley	9,565	8,875	5,940	2,927	5,059	7,063
Buckwheat	1,751	1,823	1,749	1,671	1,999	1,902
Millet	3,008	2,787	3,851	5,369	4,490	3,300
Maize	827	895	874	2,006	1,314	1,411
Total thousand dessiatines	79,874	72,523	56,673	43,587	51,824	65,770
Total thousand acres	215,659	195,812	153,017	117,674	139,524	177,579
% compared to 1913	100	90.9	71.0	54.6	64.9	82.4

is expected that 88 to 90% of the pre-war area will be sown, and in 1927 the sown area will reach 100% of the pre-war figures.

Among the food grains, rye, wheat, oats and barley are most cultivated in the U.S.R.R. In 1913 the area under these crops was distributed in the following way; rye 29%, wheat 34%, oats 19%, barley 12%. The other 6% of the area was sown with other grains. The area sown under rye for the years 1913-1924 was little changed; this is the principal food of the population, and is also the most sturdy grain. However, on the other hand the areas under oats, barley and particularly wheat, were subject to great fluctuations during this period. During the hardest year, 1922, 38% of the total area was under rye, 19% wheat, 15% oats, 6% barley, and 22% under other grains. Beginning in 1923 a great increase was seen in area sown under wheat, oats and barley, which in 1924 covered the following areas: Rye 30%, Wheat 27%, Oats 20%, and Barley 10%. Consequently in 1924 the proportion of the principal field crops is near to the pre-war, and will be finally equal to it in not more than two years.

Agriculture in Russia, during its past history, was characterized by its small crops. The average annual yield of grains in the pre-war period 1905 to 1914 was as follows:

	Poods* per dessiatine†	Bushels per acre
Rye—winter	43.7	11.8
Wheat—winter	52.1	13.0
Wheat—spring	43.7	11.1
Oats	46.2	20.7
Barley	47.0	16.0

During the war, as a consequence of the falling off of the quality of tillage (the farming being done by the women) and of the reduction of fertilization (a great quantity of stock being consumed by the armies) the yield of the grains was somewhat lowered. For the period 1922-23 the average yield was:

	Poods per dessiatine	Bushels per acre	% of reduction
Rye—winter ..	43.1	11.6	1.7%
Wheat—winter.	52.0	12.9	0.8%
Wheat—spring	37.0	9.6	13.5%
Oats	46.2	20.7	0.0%
Barley	46.2	15.7	1.9%

* Pood=36.113 lbs. (Webster).
† Dessiatine=2.7 acres.

In this manner, spring-wheat suffered mo its yield being reduced by 13.5%. The otl grains show a reduction of not more th 2%. In 1924, as a consequence of t drought, the harvest of the South Easte part of U.S.S.R. suffered greatly; 12 Provin were affected, of which 6 suffered very bad The crop failure was 4 times less than t failure of 1921, the grain requirements w easily taken care of by the surplus from otl regions, but on the whole the average yi of grains for the Union, will be found to lowered by 8 to 10% as compared to 192

Increasing the yield per acre is a mo complicated and a longer problem than t re-establishment of the sown area. This closely allied to the economic system, cr rotation, quality of tillage, fertilization, se selection, and extermination of pests. T limits of the pre-war yield will soon be rea ed: the rapid increase of cattle, of fertilizatio the re-establishment of better tillage of t ground, the development of systematic gen al extermination of weeds and other pests now noticeable in the country. The numb of large horned cattle, which fell in 1922 66% of the pre-war total, in 1924 had alrea increased to 82%. The same general o look is seen in sheep-breeding and ho breeding, rapidly increasing the resources fertilization of the country. However, t limits of pre-war yield is not the goal which the country is aiming. The war a the revolution shook all the former found tions of the farmers of the U.S.S.R. The pop lation has thoroughly understood that it impossible to remain content with form methods of agriculture, that new conditio demand new methods of work, aimed not much at the increase of cultivated acrea but at the rationalization and intensificati of farming methods.

The principal foundation of agriculture Russia before the war was the triple rotati of crops. The war and the revolution show the entire destructiveness of this system, a pointed out new methods of farming. At t present time the population is very sensiti to the introduction of new methods, and adapting them whenever possible. In ge eral the efforts of the population and t program of the Government are aiming the following:

1. The transition from the system of pure- grain farming to the system of grain and ock farming.

2. The transition from triple crop rota- on to multiple crop rotation.

3. The increase in cultivation of grasses nd such crops as potatoes, beets, etc.

4. The development and amelioriation of tock raising.

5. The development of technical crops, ugar-beets, flax, hemp, cotton, etc.

6. The development of dry-farming in dis- ricts subject to drought.

7. The increased use of mechanical labour aving appliances.

8. The selection and distribution of sel- cted seeds.

9. The extension of wholesale pest de- truction.

10. The extension of improved methods f tillage, particularly the correct tillage of allow land.

Such, in a few words, is the program of he U.S.S.R. as regards agriculture, directed o the regeneration and intensification of griculture carrying with it, at the final an- lysis, the development of the bearing power f the land and the increase of yield. This s without doubt a program of several years.

At the present time the concrete measures ssisting in the introduction of improved nethods of agriculture, may be defined as ollows:—

1. The voluntary selection of any system f farming, but with the necessary condition f the introduction of multiple crop rota- ion.

2. The encouragement of the cultivation f fodder grass seeds and the exemption of reas under such crops from any taxation.

3. The distribution of grass seeds on ong term credits.

4. Premiums for individual farmers and or whole communities who have introduced orrect multiple crop rotation, in the form f exemption from taxation of from 5% to 100%.

5. Development and improvement of the ystem of experimental stations. (Their num- er has been doubled as compared to pre-war igures).

6. The development of a network of gov- ernmental and co-operative selection stations and seed farms, encouraging at the same time the seed production of the population by means of exemption of areas under seed crops from taxation, and organizing seed growers associations.

7. The establishment of a permanent Gov- ernmental seed fund to the amount of 100,- 000,000 roubles, for the purpose of issuing seed loans to the poorer peasantry and to those districts suffering from crop failures.

8. The development and amelioration of stock breeding, by the creation of Govern- mental and co-operative stud farms, by the extension of a network of public serving stations, prizes for offspring, the distribution of breeders on credit, etc.

9. The general introduction of agricul- tural machinery, producing a part of them at home factories and importing part from abroad. Machinery is distributed to the population on credits of from one to three year terms.

10. The increase in the number of agri- culturists, of agricultural schools, and the in- tensive distribution of agricultural literature, for the permanent information of the condi- tion of agriculture abroad, two permanent agricultural agencies have been established, one in the United States and the other in Germany.

11. The enlistment of the population into co-operative societies, credit societies, pro- ductive, purchasing and sales. At the pre- sent time about 20% of the rural population have been enrolled in various co-operative enterprises, but this is only the commence- ment of the process, and in the next few years it will develop very rapidly.

12. The organization of agricultural credits. A general Governmental Agricultural bank has been organized, with a chain of interconnected local credit organizations. The problem of this bank is the issuing of credits to the population for the purchase of seeds, stock, machinery, erection of buildings, ameliorative constructions, etc.

All these methods actually began to be introduced with the termination of the war, that is, beginning in 1922. During the last two years a great deal has already been accomplished, but no extensive results as re-

gards the increased crop yield could yet be expected. The results of this work will only show themselves much later.

The average annual gross crop of grains on the present territories of the U.S.S.R. (not including the independent republics formerly within the Empire) in the pre-war period (1909-1913) may be expressed by the following figures:

	Million Poods	Million Bushels
Rye	1289	937
Wheat	1315	877
Oats	897	1025
Barley	635	552
Millet	157	125
Buckwheat	69	60
Maize	133	115
Total	4495	3691

From this total, internal consumption and export to foreign markets, in millions of bushels were:

	Internal Consumption	Export	% of Export to Total
Rye	902	35	3.7
Wheat	698	179	20.4
Oats	949	76	7.4
Barley	354	198	35.5
Millet	123.5	1.5	1.2
Buckwheat	57	3	5.0
Maize	75	40	34.8
Total	3158.5	532.5	14.7

In the pre-war period Russia was the principal supplier of grain to the International market; she supplied about 20% of all the wheat dealt in on the International market and about 70% of all the barley. Next to Russia followed in order, the United States, Canada and the Argentine.

With the beginning of the Great European War, the grain production of Russia began to fall off, and the export of grain abroad fell off at the same time. In 1917, after three years participation in the war, the grain production and export of grain in Russia, are shown by the following figures:

	General Harvest		Export		
	Million Poods	Million Bushels	Million Poods	Million Bushels	% of Export to Total Crop
Rye	1120	814.5	—	—	—
Wheat	815	562	12	8	1.4
Oats	797	911	—	—	—
Barley	435	378	2	1.7	0.5
Millet	140	112	—	—	—
Buckwheat	67	58	—	—	—
Maize	128	111	—	—	—
Total	3502	2946.5	14	9.7	0.3
% compared to 1913	79.8	—	—	1.8	—

In this way, the general harvest of gra in Russia, in 1917, totaled already 79.8% the pre-war figure, and export was only 1.8 of the pre-war export, that is, it had pra tically stopped by the beginning of the revo ution.

During the civil war, the production grain continued to fall off, and export stopp after 1917; moreover, during 1921, in co sequence of the terrible drought, which a fected one-fourth of the sown area of Russi a great quantity of grain had to be importe 46 million poods or about 37 million bushe were imported.

The year 1922 was the turning point. T harvest of this year, notwithstanding t great decrease in sown area, was found to l qualitatively fairly high, which permitte not only the satisfaction of the demands interior consumption, but after a four ye period, the re-establishment of export. T figures for the harvest and export for th year are as follows:

	General Harvest		Export		
	Million Poods	Million Bushels	Million Poods	Million Bushels	% of Export to Total Crop
Rye	1223	890	60	44	4.9
Wheat	544	358	22	15	4.1
Oats	507	579	5	6	1.0
Barley	248	215	10	9	3.6
Buckwheat	85	74	—	—	—
Millet	262	209	—	—	—
Maize	168	149	—	—	—
Total	3037	2474	97	74	3.0

When compared to the pre-war production e gross production for 1922 amounted to 5% whereas the sown area was only 54%. he export for this year was 3.% of the hole harvest. Export was possible because e quantity of cattle was 66% of the pre-ar total, which greatly decreased the de-and on fodder grains, and besides this, dur-g the time of the war and the revolution, e production of potatoes and vegetables as greatly increased, replacing a large per-ntage of grain for human food and animal dder.

The next year, 1923, the yield per acre of e grain was somewhat less, but as the sown ea had increased by 1923, the general crop grain was greater than 1922. Export in-eased at the same time. The general gross oduction and export from the crop of this ar, according to preliminary figures lately ceived, are estimated as follows:

	Gross Crop		Export		
	Million Poods	Million Bushels	Million Poods	Million Bushels	% of Export to Total Crop
ye	1158	842	96	70	8.3
heat	635	424	45	29	6.8
ats	576	658	8	9	1.3
arley	322	280	20	17	6.0
uckwheat .	87	76	3	2.5	3.3
illet	220	176	—	—	—
aize	134	119	5	4	3.3
Total ..	3132	2575	177	131.5	5.1

The total crop of 1923 was greater than e crop of 1922 by 95 million bushels. The port from the crop of 1923 increased by million bushels as compared to the prev-us year, reaching in total the sum of 131 d a half million bushels, which is 5.1% of e total crop. The remaining surplus was ed for the needs of the rapidly increasing rds of stock. In addition to this, there as a surplus in the hands of the popula-n at the time of harvesting the crop of 24, which was somewhat greater than that previous years. In July, 1924, this was es-nated to be 150-170 million poods (120 - 130 illion bushels).

The crop for 1924, according to estimates ade in June, was expected to be an average one. The minimum production of all grain crops was expected to be 3,200 - 3,300 million poods or 2,600 - 2,700 million bushels. The increase over the crop of 1923 was estimated to be 100 - 150 million poods or from 80 - 110 million bushels. However, the drought of July of this year affecting the South-Eastern portion of the European part of the U.S.S.R. greatly decreased the crop. Twelve grain producing provinces were affected by the drought, of which 6 provinces suffered badly. The gross crop of grain in the whole U.S.S.R. in consequence of the drought, was decreased by 500 million poods. The actual crop in this year is estimated to be 2,700 million poods, so that together with the surplus of the previous year the general grain resources of the U.S.S.R. amount to 2,850 million poods or 2,350 million bushels.

In connection with these events, the foreign press has repeatedly reported a new famine in the U.S.S.R. These reports do not conform to the actual facts.

It cannot be gainsaid that the crop failure in those districts where the results of the crop failure in 1921 are still being felt, necessitates considerable relief from the Government for the sufferers. But in 1924 the U.S.S.R. is in possession of sufficient grain resources to render this relief, and it is being rendered where necessary. For the satisfaction of the needs of the sufferers, 80 million poods of grain are required. This quantity is covered by the surplus of other regions without difficulty.

As regards export of grain, in view of this crop failure, the Government of the U.S.S.R. is approaching this problem with great care. Before the drought of July, the exportable surplus from the crop of 1924 was estimated to be 400 million poods. (About 320 million bushels). In connection with the crop failure, at the present time, attention is being centered on the satisfaction of internal demands. Only after the internal market has been satisfied, the surplus will be designated for export. At the present time, the amount for possible export has not yet been definitely determined.

Grain elevators in Russia began to be built just before the war. During the war and the revolution construction was not continued. For this reason, the number of eleva-

tors is inconsiderable; the bulk of marketable grain is handled in bags.

In 1924, 5 terminal elevators were working (at ports) with a total capacity of 12 million poods or 10 million bushels, and 91 interior elevators, with a capacity of 48 million poods or 35 million bushels. All elevators are under the control of the State Bank. At the present time steps are being taken to extend the chain of elevators. A special commission on elevators has been appointed by the Council of Labour and Defence, inviting, in addition to governmental organization, the participation of peasants co-operative organizations. In 1924 a large new elevator is being built in the port of Nicolaev.

The principal ports through which grain is handled for foreign markets are Odessa, Nicolaev, Novorossiisk and Kherson on the Black Sea; Taganrog on the Sea of Azov, and Leningrad on the Baltic.

The principal purchasers of grain in 1923 were Germany, Turkey, Finland, Esthonia, Latvia and Holland. In 1924 a considerable quantity was sold to France, Denmark, Norway and Italy.

From the beginning of the revolution a State monopoly of Foreign trade was declared. Planning and regulation of all external trade, and of the export of grain, is in the hands of the Commissariat, in particular, for foreign trade. Under the control of the above mentioned Commissariat, foreign trade is being carried on by co-operative unions (such as Centrosoyous, Selskosoyous and others) in addition to Government organizations. As regards internal trade, in addition to Governmental and co-operative organizations, private capital is interested, working mainly in the retail trade.

Such, in general is the situation as regards the grain production of the U.S.S.R. for the last decade. From the beginning of the Great War and till the end of the civil war in 1922, it systematically and rapidly decreased. 1922 was the turning point. Aft 1922 a revival was shown, and notwithstan ing a short period of only two years, co siderable results have been attained. Th sown area increased from 54% to 82% the pre-war area, and in 1927 it is expecte that the whole pre-war area will be sow At the same time the foundations are bein laid for increasing yield, the results of whic will only be seen in a year or two. In 192 the grain production of the U.S.S.R. is e pected to be 100% of the pre-war produ tion.

Further prospects in the U.S.S.R. for agr culture and in particular for the grain i dustry are enormous. One half of the blac lands have not yet been cultivated, to sa nothing of other soils. On the other han there is no scarcity in the agricultural po ulation, which totals 80% of the whole po ulation of the country.

However, after the revolution, the positio of the U.S.S.R. as a supplier of agricultur produce on the international market has bee considerably changed. Before the war, e tensive grain farming prevailed in Russi After the revolution this had to be change for a more intensive stock raising system farming, transferring the center of gravit on the International market on animal pr ducts and products of special cultivatio The new system will involve a greater interna consumption of grain.

Special and Industrial Cultures

From the number of special and industri cultures, the principal ones economically ar potatoes, sugar-beet, flax, hemp, cotton, su flower and tobacco. The war and the revol tion was reflected in the damage of these cu tures greater than even in the culture grain, and the process of change is seen i the same succession as in the case of th latter. The greatest decrease is shown i 1922 and after this a gradual revival begin The area under these crops was as follows:

	1913		1922			1924		
	Thousand Dessiatines	Thous. Acres	Thous. Dessia.	Thous. Acres	% as to 1913	Thous. Dessia.	Thous. Acres	% as to 1913
Potatoes	2718	6938	2351	6347	91.9	3150	8505	120.3
Sugar Beet	700	1890	169	456	24.0	312	842	43.9
Flax	1026	2774	420	1134	42.0	819	2211	81.9
Hemp	650	1755	135	364	21.4	557	1504	88.4
Sunflower	817	2205	1470	3989	181.0	1803	4868	221.2
Tobacco	56	151	5	13	8.6	41	112	74.6
Cotton	785	2119	52	140	6.6	442	1193	56.8

From this it may be seen that the sown ea under special and industrial crops in e U.S.S.R. shows a very large decrease in 22; such crops as cotton and tobacco aled only 6 to 8% of the pre-war figures. ot much better was the situation of sugar-et and hemp, which amounted to 21 to % of pre-war total. The only exceptions re potatoes and sunflowers, of which po-oes amounted to 91% and sunflowers 181% pre-war production. The maintenance of ea of the potato and the increase of the ltivation of the sunflower are explained by e fact that these two products played a edominant part in the food of the popula-on.

Beginning from 1923 is noticed a rapid in-ease within the last two years. This may be own in % relative to pre-war figures as llows:

	Sown Area 1922 % of pre-war Area	Sown Area 1924 % of pre-war Area	Increase % of pre-war Area
otatoes	91.7	120.3	28.6
ugar-beet ..	24.0	43.9	19.9
ax	42.0	81.9	39.9
emp	21.4	88.4	67.0
unflower ...	181.0	221.2	40.2
obacco	8.6	74.6	66.0
otton	6.6	56.8	50.2

The most rapid increase is seen in hemp, bacco and cotton as the crops which suf-red most during the war and the revolution. or the two years, 1922 to 1924 the area wn under hemp was increased four times d under tobacco and cotton 8½ times. For is period the areas under flax and sugar-et doubled, and under potatoes and sun-wer greatly increased, 28% and 40% res-ctively.

With respect to the pre-war area under ese crops, the special and industrial prod-ts show a great variation in 1924. For this ason this question, as also the question of e immediate future of these cultures, de-rve closer attention.

The area under potatoes in 1924 was 8.6% of the pre-war area. The rapid owth of potato production may be ex-ained by many reasons. First of all, the tato is not a plant demanding particular tention, giving a fair crop under ordinary peasant conditions, and as a crop sowed in rows is a very valuable agricultural factor.

Secondly the methods of the use of the potato are most varied. A very large proportion of the potatoes is used for human food. No less value has the potato in the production of starch, dextrine, glucose and molasses. This production is rapidly increasing during the last few years. Finally, the potato is becoming very valuable latterly as food for stock. According to figures taken lately in certain districts the potato is proving to be a most profitable food for animals.

This applies to the Northern and temperate regions, where grains and grass give a comparatively small yield, and a rapidly developing dairy industry requires a large quantity of fodder for the cattle. The increase in area sown in potatoes is far from being stopped. It will play a large part in crop rotation and stock raising in the country.

The area under sugar-beet in 1924 was 43.9% of the pre-war area. This is a product which is developing least rapidly. The increase in production of sugar-beets is going strictly in accordance with the re-establishment of the sugar industry. The return to the pre-war basis is expected in 1929 with an annual increase of from 10 to 12%.

Flax is sown on 81.9% of the pre-war area. Russia was always the leader in the world's flax production, giving 80% of the total output of the world. In 1924 the U.S.S.R. was able to export up to 7½ million poods (120,000 tons) of flax fibre. The return to pre-war production is expected in 1927.

The area under hemp was 88.4% of pre-war area in 1924. The total production of fibre is estimated to be 12,000,000 poods (about 200,000 tons). About 7% will be consumed by the home markets and about 30% is designated for export (up to 60,000 tons). The area under this crop will return to pre-war area in 1927.

The area under sunflower in 1913, was 2,205,000 acres. In 1924 it was 4,818,000 acres, that is, the area, in comparison to pre-war area totals 221.%. The crop of seed this year will total 45,000,000 poods (750,000 tons). From this total 80% will be needed

for home consumption and the remaining 20% will be available for export.

The culture of tobacco suffered greatly during the war and the revolution. In 1913, 151,000 acres were sown in tobacco. In 1922 this was decreased to 13,000 acres, that is 8.6% of the pre-war area. For the last two years a very rapid re-establishment is found. In 1924 the sown area was 74.6% of the pre-war area, and will be completely re-established not later than 1927 or 1928.

A still greater loss was suffered in the U.S.S.R. in the culture of cotton. In 1913, 2,119,000 acres were planted in cotton. By 1923 this was decreased to 140,000 acres which was only 6.6% of the pre-war area. In 1924, 1,193,000 acres were planted in cotton which is 56.8% of the pre-war area. In view of the extreme importance of this crop in the re-establishment of the native textile industry, the development of its culture is being given very careful attention by the central organs of the Government. The pre-war production will be reached in 1928. Before that time the lack of cotton for textile purposes will be supplied by importation principally from the United States.

CONCLUSION

The upheaval caused by the war and the revolution is not yet fully overcome. It would be futile to under-estimate that great and complicated work which has yet to be done. But that success which is noticed during the past two years, gives a perfect confidence that the U.S.S.R. is emerging and will soon completely emerge from these incredible difficulties which were the consequence of events provoked by historical necessity.

The revolution shook the agriculture and the psychology of the farmer of the U.S.S.R. to its foundations. Not only must the psychology change, but also the whole system of economics. For this reason it would be a mistake to believe that the recovering agriculture of the U.S.S.R. will be a repetition of the pre-revolutionary system. The old extensive methods must give place to more intensive ones. The change from purely grain farming to mixed grain and stock farming is one of the fundamental problems which is now facing the Government, the co-operative organizations and the farmers themselves. Together with this the significance of the U.S.S.R. as a supplier of agricultural products on the markets of the world will als change. As staple exports, in addition grain, will be animal products and produ tions of special cultures.

This year, notwithstanding the sufficien of grain within the country, the U.S.S.R. buying a lot of wheat from Canada. Th grain is destined for the Far East. Similar pu chases are not without possibility in th future, as local agriculture in the Far Ea is as yet poorly developed, and the tran portation of grain for thousands of mile when there are rational methods of use withi the country, may be economically unprofi able.

In connection with the reconstruction economics in the U.S.S.R. a great deman is now being observed for agricultural mac inery and implements. The Government an co-operative organizations are paying a gre deal of attention to the development of i ternal agricultural machine building. B the demands of the population are increasin so rapidly that it is impossible to suppl even one-half of the needs of home produ tion. Intensive importation of machinery an implements, not excluding tractors, is nece sitated.

A great deal of attention is now being give in the U.S.S.R. to experimental work, sele tion, and seed raising. With a view to fami iarizing themselves with the situation in thes lines, two years ago, Professors Vavilo and Tulaikoff visited the United States an Canada. America and Canada have borrov ed in their time a great deal from Russi with regard to grain and fruit farming. Th recent works of Saunders, Burbank and oth eminent scientists are necessitating ou turning our eyes, particularly now towar America. It cannot be denied that these cu tural relations will materially assist the r birth of our country.

In addition one must not forget, that th U.S.S.R. possesses not a few resources whic may be valuable to the agriculture of Ca ada and the United States. Besides som valuable kinds and species of agricultura plants, a number of which are already know in Canada, the U.S.S.R. has a number o original species of agricultural animals whic may prove interesting in carrying on sele tional work. It is quite possible that o this our cultural relations will be still fu ther strengthened.

Artificial Self-Pollination of Red Clover*

LAWRENCE E. KIRK

Professor of Field Husbandry, University of Saskatchewan, Saskatoon.

INTRODUCTION

The object of the pollination experiment, which this paper is a preliminary report, is to study the possibilities for improving d clover by the method of inbreeding which s been employed so successfully for a num- r of years with corn, and more recently has en applied to the improvement of timothy, nflowers and some other open fertilized ops. The feasibility of attacking the prob- n in this way obviously depends on whether is possible to produce self-fertilized strains red clover and on the effects of self- rtilization.

The rather extensive literature dealing with e question as to whether red clover can successfully self-fertilized or not has been viewed by Westgate, Coe and co-workers 0) and more recently by Malte (7). These thors cite an extensive array of pollina- on experiments by Fruwirth, Sirrine, Witte, randsen, Pammel and King, Westgate, Coe nd associates, and others, all of whom con- ude that red clover is practically self-sterile. et the evidence is by no means conclusive as any investigators have secured a few seeds om isolated plants, sometimes with and metimes without manipulation of the flow- s. Nearly all, however, are agreed that d clover rarely sets seed in the absence of pollinating agency. A few of them, notably echan, Armstrong and McAlpine are agreed the view that red clover is self-fertile.

After carefully weighing the evidence Malte ncludes as follows: "In comparing the idence available in the matter of the fer- lization of red clover it is apparent that the idence supporting the contention of self- rtility is very weak and under the circum- ances it may be considered justified to con- ude that red clover is normally, if not al- ays, self-sterile".

More recently Schlecht (9) obtained only) seeds from 8589 flowers artificially self- llinated, while control tests where the flow- ers were both artificially cross pollinated and exposed to the visits of insects gave 32.8 to 68.5 percentage of seed set. He concludes that the few seeds obtained may well have been due to the chance introduction of foreign pollen and that the autosterility of red clover has once more been proved.

In December 1922, Fergus (2) published the results which he obtained in two seasons' work with red clover. The first year (1921) he succeeded in getting 153 seeds from 32 out of 650 self-pollinated heads, each representing a separate plant. This gave an average production of .24 seeds per plant. The next year all of the seed was planted and from one to fourteen heads on each normal plant was selfed. These gave average numbers of 13.1 seed per normal plant, 2.2 seed per self-pollinated head and nine seeds per seed yielding head. The author expresses the belief that self-fertile lines exist in red clover, citing as evidence the seed yielding ability of some groups of sibs when self-pollinated and the inability of the other groups to become self-fertilized. The fact is emphasized that first year self-fertilized families which set a large number of seed were the progeny of good seed yielding mother plants, and conversely, the families which either failed to fertilize or produced only a few seeds, were the progeny of plants from which only a very few seeds were secured.

Results of Artificial Self-Pollination

In the summer of 1923 † the writer began some pollination experiments with red clover. Two varieties were used, viz: Minnesota and Altaswede. Altaswede red clover is a mass selected variety produced at the College of Agriculture, Edmonton, Alberta. The Minnesota strain is a commercial lot grown from

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† At University Farm, St. Paul, as a special study in plant breeding under Dr. H. K. Hayes.

FIGURE I. A part of the red clover nursery showing a very uniform and extremely weak family of 13 plants. (See Table VI.)

TABLE I.
Results obtained by Self-pollinating Red Clover.

	Minnesota Red Clover	Altaswede Red Clover	Both Varieties Total	Both Varieties Average
Number of head self-pollinated.....	230	200	430*	
Number of heads that produced seeds	58	88	146	
Total number of seed produced.....	430	904	1334	
Average number of seed set per self-pollinated head	1.87	4.52		3.2
Average number of seed set per open-pollinated head	44	44		44
Average number of seed from selfed seed yielding heads	7.4	10.27		8.83
Percentage of the "normal seed set" by artificial self-pollination	4.25	10.27		7.26

* Each head represents a separate plant.

Table II. The distribution of heads (or plants) according to the number of seed produced by open and by self-pollination.

Variety and Method	Seed Number Classes of Red Clover																							Total
	0	3‡	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93				
Minnesota																								
Open-Poll	0		2	2	2	1	3	4	2	2	1	3	2	1	0	1	1	0	0	3†				30
Self-Poll	172	33	13	4	1	5	1	0	0	0	1													230
Altaswede																								
Open-Poll	0					2	3	4	6	2	3	4	3	0	1	0	1	1						30
Self-Poll	112	46	15	5	5	7	1	6	1	1	1													

† One of these belong to class 113.

‡ The seed number classes are designated by the center value of each class.
Thus 3=1 to 5; 8=6 to 10; etc.

Minnesota seed. The method used for effecting self-pollination was the same as that employed by Fergus and the same as one of the methods used by Westgate and Coe and coworkers at an earlier date.

The method consisted of bagging the heads singly, just as the petals were beginning to show and before any of the flowers had opened, with one-quarter pound Kraft paper bags. Some of the leaves near the top were removed together with any small heads that were beginning to form. The bag was placed over the clover head, crumpled in closely around the stem at the bottom and tied with a piece of string. The string was passed two or three times around the stem and tied with a single bow to facilitate its removal. It was found necessary to exercise care in tying, not to bind the bags too low on the stems, so that the latter had room to elongate a little without doubling back and not to draw the string so tightly as to injure the stem. After 48 to 60 hours the bags were removed, the heads rolled gently between the thumb and fingers, and the bag replaced and left undisturbed until the heads ripened. As a precaution against the introduction of foreign pollen, the fingers were wiped on a piece of cotton after each head was done.

Artificial self-pollination was begun on July 3rd and concluded on July 18th. Four hundred and thirty heads in all were manipulated, each head representing a separate plant. Two hundred were of the Altaswede variety and the balance were of Minnesota red clover. At the same time 30 open-pollinated heads were taken at random from each variety and threshed to get an estimate of the seed set under natural conditions for pollination. The average for each variety was 44 seeds per head.

When all of the bagged heads were harvested they were carefully examined for seed and it was found that the percentage of seed set by artificial self-pollination as compared with the amount set under conditions of natural cross-pollination was 4.25 and 10.2 for Minnesota and Altaswede red clover respectively. This makes an average of 7.2 percent for the total of 430 heads. Tables I and II summarize the results secured.

Results Secured from Seed of Self-Pollinated Plants Grown in the Greenhouse

In the spring of 1924 at the University of Saskatchewan, Saskatoon, the seeds secured by self-fertilization were planted in the greenhouse. All of the seeds were pricked with a needle to insure germination, a practice which was found to be 100 per cent successful with hard seed of sweet clover. A considerable number of the seeds planted failed to germinate. Of those which germinated a large number produced weak seedlings. These never grew very large and some of them died before being transplanted into the field. Small size and lack of vigour characterized many of the families of seedlings which appeared otherwise healthy in form and color. The difference in vigour of the plants from open-fertilized seed and most, but not all, of the plants from self-fertilized seed was very evident even in the greenhouse.

Table III is a numerical tabulation of notes taken from the time of planting the seed until the seedlings were transplanted into the field. Of 73 seedlings which were grown from seed of open-pollinated plants of the Altaswede variety only six could be classified as weak.

Chlorophyll Deficiency

It will be observed in Table III that 41 out of a total of 492 plants of the Altaswede variety were chlorophyll deficient. These were found in 21 out of the 81 self-fertilized lines studied. Twenty-four of the chlorophyll deficient plants were albinos which never developed beyond the seed leaf stage. The others had pronounced etiolated leaves.

Fergus (2) reported chlorophyll deficient seedlings of red clover in four out of a total of 32 groups of sibs. He regarded their occurrence as convincing evidence that his first year self-fertilized families were actually the product of self-fertilization.

The occurrence of chlorophyll deficient seedlings in self fertilized lines of red clover is interesting in view of the fact that they have been found so frequently in maize and more recently in timothy, both of which, like red clover, are normally cross-pollinated. Hutchinson (4) states that 17 of more than 60 hereditary factors of maize are primarily concerned with chlorophyll development. Lindstrom (5, 6) lists white, virescent-white and yellow as the three seedling types which occur most frequently and has worked out their genetic relationships. In a test of 1872 self-pollinated ears which were grown under greenhouse conditions, Hutchinson (4) reports that 530 gave chlorophyll deficient plants in the seedling stage.

Hayes and Barker (3) report the occurrence of albino seedlings in five out of twelve first year self-fertilized lines of timothy. They regard the appearance of these and other

Table III. Summary of observations on greenhouse plantings of Red Clover Seed from Self-pollinated Plants.

		Altaswede Variety	Minnesota Variety	Total
(1)	Seeds planted †	692	327	1019
(2)	Seeds germinated	492	257	749
(3)	Chlorophyll deficient seedlings	41	‡	
(4)	Albino seedlings in (3)	24	‡	
(5)	Weak seedlings	155	‡	
(6)	Number of seedlings that died in the greenhouse *	80	121	201
(7)	Number of seedlings transplanted into the field	412	136	548
(8)	Number of self-fertilized lines represented in (7)	81	34	115

‡ Data not taken.
† The maximum number of seed of any one family planted in the greenhouse was 20.
* There was no loss from damping-off or mechanical injury.

abnormalities as a good indication that self-fertilization in timothy, as in corn, is a logical means of freeing the strain of undesirable recessive characters.

Field Results with Self-Fertilized Lines

The red clover seedlings were transplanted from the greenhouse into a block of very uniform soil early in June. The plants were placed three feet apart each way to allow ample room for individual development. All of the seedlings were carefully handled, transferred from the pots with the soil in which they were growing, and watered two or three times until they were well established. It was considered important that none of the plans should sufffer a setback, and thus prejudice a just comparison by unequal development. This result was happily secured.

In the field the families of red clover from self-fertilized seed made very interesting material for observation in two important respects, viz: their lack of size and vigour as a whole and the greater uniformity possessed by plants within each family as compared with plants from open-fertilized seed.

Reduction in Vigour of Growth

The phenomenon of decreased vigour due to self-fertilization of normally cross-fertilized crops, has been observed and commented upon by many investigators. An excellent example is afforded by maize which is almost entirely cross-pollinated under field conditions and has been studied more extensively than any other crop.

East and Jones (1) in a recent monograph (1919) reviewed the classic experiments of Shull and East which were begun in 1905 to study the effect of self-fertilization in maize. It was found that every self-fertilized maize plant is invariably inferior in size, vigour and productiveness to the progeny of a normal cross-bred derived from the same source. The reduction in size and vigour was greatest in the first generation becoming less and less in each succeeding generation. After nine generations the self-fertilized lines were approximately one-third as productive as the original variety, some of them being more vigorous than others.

McRostie (8) found in the sunflower another excellent example of a marked decrease in size as a result of inbreeding. Having studied a considerable number of families, the progeny of five generations of self-fertili-

FIGURE II. A part of the red clover nursery. The second row from the right up to the white stake is a check row of Altaswede red clover from seed of open pollinated plants. (See Table V.)

zation, he states that most of the inbred strains vary greatly with respect to vigour, being much smaller in size than the commercial lots from which they were selected.

On the other hand self-fertilized lines of timothy do not appear to exhibit much, if any, loss of vigour. Referring to the results of five generations of inbreeding with this crop, McRostie states that most of the strains consistently outyielded commercial mixtures and a few of them outyielded a mixture of all of the better strains under test. He considered that if any reduction in vigour, due to inbreeding had occurred, such high yields would not have been secured.

Fergus (2) did not mention loss of vigour, as such, in discussing his self-fertilized strains of red clover, but he observed chlorophyll deficiency and a few other abnormalities in a number of seedlings which resulted in the death of the plants.

Reduction in size and vigour was an outstanding characteristic of the self-fertilized lines of red clover as they appeared in the field throughout the summer in the experiment herein reported. Table IV classifies the plants as a whole with respect to development. The comparison with plants from seed produced by open-fertilization is an indication of the loss of vigour due to selfing, although it does not give an adequate idea of the extreme weakness which characterized some of the lines. Nevertheless only 9 plants of the Altaswede and 15 of the Minnesota variety died in the field during the season. All of the so-called weak plants in Table IV were much reduced in size, many of them consisting only of a small tuft of leaves, but generally they were normal in colour and otherwise of healthy appearance.

Reduction in Variability

The second obvious difference between the self-fertilized lines of red clover and plant from open-fertilized seed was a marked re duction in variability. This is in accord wit the results obtained by Fergus who right regarded it as further evidence of self-fertil zation. Reduction in invariability of practica ly all characters studied is cited by East an Jones (1) as a conspicuous result of inbreed ing of maize. McRostie (8) states that hi self-fertilized strains of sunflowers are re markably uniform with regard to all dis tinguishable morphological characters.

In the present investigation a study wa made of a number of the most conspicuou characters of all red clover plants withi the self-fertilized lines as well as those fro seed of open-pollinated plants. Notes wer taken with respect to vigour of growth, habi of growth, number of stalks, leafiness, siz of leaves, colour of leaves, leaf markings, de gree of pubescence and the presence or absenc of flowers. In the case of leaf character only the extremes were noted as when th leaves were exceptionally dark or light green unusually large or small, and the marking very distinct or absent. Degree of pubescenc was designated by the figures 0, 1, 2, 3, 4.

As to the other characters the plants wer placed in three natural classes as weak, med ium and strong for vigour; erect, medium and spreading for habit of growth; numerous few and absent for number of stalks; an leafy, medium and sparce for leafiness.

Data taken according to the method jus described does not give an accurate expres sion of the nature of the variability but i serves very well to bring out the uniformit in certain characters possessed by individual of any one family. In order to enable th reader to visualize the uniformity possesse by many of the strains data on five of thes are presented in Tables VI to X. As a basi of comparison with plants of the same variet

Table IV. Comparison of Red Clover Plants from Self-fertilized Seed with Plants from Open-fertilized seed of the same Varieties with Respect to Vigour of Growth.

Variety and Treatment	Number of Plants Expressed in Percent			
	Dead	Weak	Medium	Strong
Altaswede plants from self-fertilized seed..	2.1	35.0	42.0	20.9
Altaswede plants from open-fertilized seed..	0.	2.7	11.0	86.3
Minnesota plants from self-fertilized seed..	11.6	47.3	32.6	8.5
Minnesota plants from open-fertilized seed..	.0	30.0	20.0	50.0

FIGURE III. Self-fertilized families of Altaswede red clover.
Above—A uniform and weak family of plants (See Table VII).
Center—A uniform family of plants with bunched habit of growth. (See Table IX.)
Below—A uniform family of plants with no reduction in vigor of growth. (See Table X)).

from seed of open-pollinated parents, 18 consecutive plants from one of the check rows have been used and the data tabulated in the same way in Table V. It is believed that these tables will convey a better idea of the uniformity of the strains and the various combinations of characters observed than could a lengthy description.

From Table V it will be seen that the plants from open-fertilized seed are all strong and leafy but exhibit much variability with respect to all of the other characters except color of leaves, which is normal.

A very weak but extremely uniform family is described in Table VI.

A family similar to the one shown in Table VI but having light green leaves, is presented in Table VII. It also possesses greater variability with respect to leafiness.

The family described in Table VIII differs from the last two in that leaf markings are absent and all of the plants bear flowering stalks which produce flowers. It is very uniform in habit of growth and colour of foliage.

Table IX represents a very uniform family without flowering stalks. It is peculiar in that the green leaves of every plant are bunched together above the crown (See Figure 3, center).

A very vigorous and promising family of plants is represented in Table X. The individuals of this strain appear to be at least as vigorous as any of the plants from seed of open-fertilized parents and the strain as a whole to be about 25 percent more productive.

DISCUSSION

The results of artificial self-pollination of red clover presented in this paper agree with and supplement the results reported by Fergus (2). During the past two years Fergus has continued to self-pollinate his inbred strains with results * that have confirmed his previous conclusions. The factor or factors which determine self-fertility have shown marked segregation and many lines have been lost because a plant apparntly lacked the necessary genetical composition for self-fertility. A considerable number of plants have been secured which appear highly self-fertile, and Fergus expects that as the strains become more and more homozygous this character will become homozygous in some of the lines.

The production of self-fertile lines of red clover suggests the possibility of effecting improvement in the crop by the same mode of attack that has been used with maize, i.e., inbreeding for several generations to produce uniform strains and subsequent crossing of those which prove superior. That inbred red clover strains behave in a similar manner to maize is evidenced both by the reduction in vigour of growth and the reduction in variability within each of the strains. The occurrence of chlorophyll deficient seedlings and other abnormalities indicates that strains of red clover may be freed from undesirable recessive characters by self-fertilization.

* Unpublished data.

The desirability of improving the red clov crop with respect to seed production has be widely recognized. This has been especiall emphasized by Westgage, Coe and co-worke (10). They discuss the prevalence of i fertile ovules as one of the causes of po seed yields and express the opinion that th is to a greater or less extent a heredita character. If red clover strains can be s cured which have a high degree of sel fertility, it would seem that an important a vance will have been made toward impro ing the crop with respect to yield of see It is also reasonable to assume that simila possibilities exist for improvement of th crop with respect to hardiness, disease resi tance and many morphological characters o economic importance.

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Table V.—Altaswede Red Clover from Open-fertilized Seed.

Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Vigor of Growth	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Habit of Growth	Spr.	E	Spr.	Spr.	M	E	M	M	M	E	E	M	E	M	E	E	M	M
No. of Stalks	N	N	O	N	O	O	I	N	O	N	N	N	N	F	O	2	O	O
Leafiness	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L
Size of Leaves	—	Lg	Lg	—	Lg	Lg	—	—	Sm	—	Sm	Sm	Sm	—	—	—	—	—
Color of Leaves	—	—	DG	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leaf Markings	—	—	—	Ab	Dis't	—	Dis't	—	Ab	Dis't	—	—	Dis't	—	—	Dis't	—	—
Pubescence	4	2	2	3	2	1	2	3	2	3	3	3	2	1	2	2	2	1
Flowers	F	F	O	F	O	O	F	F	O	F	F	F	F	F	O	F	O	O

M-medium; S-strong; W-weak; E-erect; Spr-spreading; B-bunched; N-numerous; F-few; L-leafy; Sp-sparcely leaved; Lg-very large; Sm-very small; DG-dark green; LG-light green; Dis't-exceptionally distinct; Ab-absent; O, 1, 2, 3, 4,-degrees of pubescence; F-flowers present; O-absent. A dash (-) may indicate any degree between two extremes of expression of the character.

Table VI.—Altaswede Red Clover from Self-fertilized Seed (Family XX—C)

Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Vigor of Growth	W	W	W	W	W	W	W	W	W	W	W	W	W
Habit of Growth	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm
No. of Stalks	O	O	O	O	O	O	O	O	O	O	O	O	O
Leafiness	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Size of Leaves	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm
Color of Leaves	Y	—	—	—	—	—	Y	—	—	—	—	—	—
Leaf Markings	—	—	—	—	—	—	—	—	—	—	—	—	—
Pubescence	2	2	2	2	2	2	2	2	2	2	2	2	2
Flowers	O	O	O	O	O	O	O	O	O	O	O	O	O

For explanation of abbreviations see Table V.

Table VII.—Altaswede Red Clover from Self-fertilized Seed (Fsamily XX—N)

Plant No.	2	1	3	4	5	6	7	8	9	10	11	12	13	14	15
Vigor of Growth	W	W	W	W	W	W	W	W	W	Dd	W	W	W	W	W
Habit of Growth	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
No. of Stalks	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Leafiness	M	Sp	M	M	Sp	M	M	Sp	Sp	M	Sp	Sp	Sp	Sp	M
Size of Leaves	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Lg	Sm	Sm	Sm	Sm	Sm	Sm	Sm
Color of Leaves	LG	LG	LG	LG	LG	LG	LG	LG	LG	LG	LG	LG	LG	LG	LG
Leaf Markings	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pubescence	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flowers	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

For explanation of abbreviations see Table V.

Table VIII.—Altaswede Red Clover from Self-fertilized Seed. (Family XX—d).

Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Vigor of Growth	S	M	S	S	S	M	M	S	M	M	S	S	S	S	M
Habit of Growth	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
No. of Stalks	N	N	N	N	N	N	F	F	F	F	F	F	N	F	F
Leafiness	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Size of Leaves	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Color of Leaves	LG	LG	LG	LG	LG	LG	LG	LG	LG	L G	LG	LG	LG	LG	LG
Leaf Markings	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab
Pubesence	1	1	2	2	2	2	1	2	2	2	1	1	2	1	1
Flowers	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

For explanation of abbreviations see Table V.

Table IX.—Altaswede Red Clover from Self-fertilized Seed (Family XIV—C)

Plant No.	1	2	3	4	5	6	7	8	9	10	11	12
Vigor of Growth	M	M	M	M	M	M	M	M	M	M	M	M
Habit of Growth	B	B	B	B	B	B	B	B	B	B	B	B
No. of Stalks	O	O	O	O	O	O	O	O	O	O	O	O
Leafiness	M	M	M	M	M	M	M	M	M	M	M	M
Size of Leaves	—	—	—	—	—	—	—	—	—	—	—	—
Color of Leaves	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Leaf Markings	—	—	—	—	—	—	—	—	—	—	—	—
Pubescence	2	2	2	2	2	2	2	2	2	2	2	2
Flowers	O	O	O	O	O	O	O	O	O	O	O	O

For explanation of abbreviations see Table V.

Table X.—Altaswede Red Clover from Self-fertilized Seed (Family XX—j)

Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Vigor of Growth	S	S	S	S	S	S	S	S	S	S	S	S	M	M
Habit of Growth	M	M	E	E	E	E	M	E	M	M	E	E	M	M
No. of Stalks	O	O	F	N	N	F	O	N	O	O	F	F	O	O
Leafiness	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Size of Leaves	—	—	—	Lg	—	—	—	Lg	Lg	—	Lg	—	—	Sm
Color of Leaves	DG°	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Leaf Markings	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pubescence	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Flowers	O	O	O	F	F	F	O	F	O	O	F	F	O	O

For explanation of abbreviations see Table V.

American Foulbrood of Bees.

Experiments with Various Disinfectants on Infected Combs.

D. H. JONES

Professor of Bacteriology, Ontario Agricultural College, Guelph, Canada.

American foulbrood of bees is an infectious disease that causes heavy losses to bee keepers whose apiaries become infected, unless effective steps are immediately taken to eradicate it.

It is common in Canada, the United States, Great Britain and various European countries and has been found in Australia and New Zealand. Descriptions of bee diseases in old writings indicate that this disease with others was known to the ancients.

It was not until 1904-5, however, that the specific cause of the disease was demonstrated by White of Washington (1). He showed that a spore-forming bacillus, which he named *B. larvae* was responsible. This organism he found would not grow on the ordinary bacterial culture media but after much experimenting he discovered that it could be cultivated on media made from bee brood (2). He later found that it could be grown on egg yolk beef extract agar, (3), and, more recently he, with Sturtevant, discovered that it could be grown to greater advantage on a preparation of yeast peptone egg yolk agar,—method not published at time of writing but was kindly forwarded in letter to the writer by Sturtevant, February, 1924.

The fact that the true causal organism would not grow on ordinary culture media was responsible for other investigators, previous to White, attributing American foulbrood to *B. alvei* (4), another spore-forming bacillus that will readily grow on ordinary culture media and which is occasionally found in diseased combs, but more particularly those affected with European foulbrood. This organism, *B. alvei*, White demonstrated was simply a saprophyte, a secondary invader of brood already diseased (5).

Previous to White's discovery of a culture medium on which *B. larvae* would grow, considerable work had been done in testing the effectiveness of various chemical antiseptics and disinfectants in combating American foulbrood but with practically no beneficia result. Infected combs were fumigated, spray ed or washed with recognized standard dis infectants but when such treated combs wer again used the disease in them was still foun to be active.

After White was able to cultivate *B. larva* he tested the action of several disinfectant (6) on the spores of the bacillus and foun that even after several months exposure to 5 per cent aqueous solutions of carbolic aci the spores were not killed but would germin ate and grow when placed on his special cul ture medium. He obtained very similar result with mercuric chloride in strengths of 1-100 and 1-500. In his tests with formalin (3 per cent formaldehyde) he found that spore of *B. larvae* were alive after six hours ex posure to 5 and 10 per cent aqueous solution and after thirty minutes exposure to a 2 per cent aqueous solution.

He concludes that, (6) "While the spore were alive in the formalin suspensions afte these periods, the evidences obtained indicat that the chemical death point was being reached"...."as the destruction of the spore with formalin is a question of hours only it is possible in well selected cases that us could be made of this agent"..... "Th general conclusion in regard to chemical as disinfectants is that they offer very littl promise as a practical means for the destruc tion of the spores of American foulbrood."

In view of the non-success of the treat ment of infected combs with chemical dis infectants it was generally recommended tha such combs be melted down, the wax boile and the frames and hives thoroughly flame over with a gas torch as the only reliabl method of eradicating the trouble from a apiary. This method, however, in many case proved expensive and difficulty was ofte found in getting apiarists to comply with th requirements.

In December, 1922, under the heading Can the Combs be Saved" Dr. J. C. Hutzelan published an article (7) in which he escribes some practical experiments in the ontrol of American foulbrood by a two ays' immersion of infected combs in a 20 er cent solution of formalin in alcohol. He ound that after giving the treated combs ack to the bees the colonies remained free om the disease. He used alcohol instead f water as the diluent because of its rcogized greater powers of penetration.

As American foulbrood is widely prevalnt in Ontario causing much trouble annualy in attempts to get rid of it, Professor Milen and Mr. G. L. Jarvis of the Apiculture epartment of the College decided to try out lutzelman's solution on a number of infected ombs and asked the writer if he would make acteriological determinations of the larval cales from such combs to see if the spores f *B. larvae* had been killed.

While awaiting the arrival of Hutzelman's olution for this experiment the writer decidd to test out a number of other disinfectnts on infected combs. The following is a ecord of these experiments.

Disinfectants tested: Izal, Be-Health, Chlorzene, Formalin in aqueous dilutions, Formain in alcohol dilutions, and Hutzelman's olution.

Method of Testing

The test comprised an immersion of bee ombs infected with American foulbrood in arious dilutions of the disinfectants for varyng lengths of time, at room temperature.

Previous to immersion the combs were cut two pieces and one piece was kept untreated a control for comparison with the treated iece.

Rectangular glass museum specimen jars ere found to be very satisfactory for the imersion process. The combs were placed in iese, right side up, so that the floor of the lls should slant down inwardly. A weight as put on top of the combs to keep them om floating, and then the disinfectant was oured in and the tops sealed on. Shaking e vessels from side to side and jarring them little after the liquid was poured in facilited the displacement of air bubbles from e cells.

After the period of immersion the combs were removed, the disinfectant shaken and washed from them, and bacterial cultures were made from the larval scales on egg-yolk-yeast-agar slopes. An equal number of cultures were made from the treated and the untreated control pieces.

Yeast Peptone Egg-yolk Agar for Cultivation of B. larvae.

(Modification of Sturtevant's Method)

Fleishman's Yeast Cake...10 grams
Peptone (Difco) .....10 "
Agar .....20 "
Distilled water .....1000 c.c.

(Wash the agar in several changes of distilled water before adding it to the rest of the ingredients).

Cook in steamer or autoclave until agar is completely dissolved.

Correct acidity to Ph=7.6—7.8.

Fill into tubes (sufficient quantity for making slopes) and sterilize at 15 lbs. for 15-30 minutes.

Egg-yolk Suspension.

Place 200 c.c. distilled water in a wide-mouthed flask; sterilize.

Soak an egg in $HgCl_2$, 1-1000, for 10-15 minutes. Rinse with sterile water. With sterile knife cut off the end of the shell, pour off the white, then empty the yolk into the flask of sterile water. Thoroughly mix to form a uniform suspension. The reaction should be such that on adding 1 c.c. to 5 c.c. of the yeast peptone agar base there will be a Ph of about 6.8. Keep in refrigerator until ready to use.

Liquefy the tubes of yeast peptone agar and cool to 45°-50°C., then add aseptically 1 c.c. of the egg-yolk suspension to each tube, mix by shaking and slope.

In making the cultures several scales were removed and macerated in a drop of sterile water to form a pulpy mass. Two or three loopfuls of this pulp were then smeared over each of several slopes. These were then incubated at 37° C. and examined daily for germination of spores and growth of *B. larvae.* At each examination Gram's stained smears were made and examined whether there was visible growth on the slopes or not. Those cultures that showed germination of *B. larvae* spores with resultant growth of *B.*

larvae were considered to indicate that no beneficial effect had resulted from the treatment. Those cultures that showed no germination of the spores after fourteen days incubation were considered to indicate that the spores had been killed by the treatment. Cultures were made separately from scales taken from capped and uncapped cells.

In a number of the experiments plate cultures were made as well as test tube slope cultures. The plate cultures, however, were not nearly so satisfactory as the test tube slopes for making determinations, largely on account of the opacity of the culture medium making it difficult to see the submerged colonies, while any individual surface colonies gave only a very meager development. Where heavy streak cultures were made on the surface of agar plates, however, good growth of *B. larvae* developed in those cases where the spores had not been killed. But plate cultures more readily leant themselves to contamination than test tube cultures during the repeated examinations.

Tests with Izal

Izal is a coal tar product manufactured by Newton Chambers & Co. Ltd., near Sheffield, Great Britain. It has a phenol coefficient of 18-20 (*B. typhosus*) and is said to kill anthrax spores in four hours. It does not decompose, disintegrate nor lose its germicidal power when mixed with hard, salt, brackish or soft waters, limewash, urine, or infected organic fluid". For general cleansing and disinfection it is used in strength of 1-600 of water. For disinfection of liquid or solid organic matter it is used in strength of 1-300 of water. It is non-corrosive and non-irritant and does not injure fabrics or destroy colours. It is a first class general disinfectant and is much used in Great Britain by Government, Medical and Public Health Services in hospitals and on stock farms, stables, poultry farms, apiaries, etc."

In view of the above well substantiated claims and the fact that in Great Briatin Izal is generally used in apiaries to combat European foulbrood and other bee diseases and the bees are not interfered with by its use about the hives, it being non-irritant, we decided to test it out on American foulbrood infected combs.

Accordingly dilutions were prepared both in water and in a high grade denatured alcohol. Combs were treated in these at room temperature and bacterial cultures made and incubated at 37° C. as above described. The results are given in the accompanying table.

(Note: In the alcohol izal mixtures a brownish precipitate was thrown down after a few hours standing).

Growth of *B. larvae* was occasionally slightly in evidence after 24 hours but much more so after 48 hours incubation.

The cultures made from the control portion of the comb that was not treated gave

TABLE I.

Disinfectant	Combs immersed 24 hrs.						Combs immersed 48 hrs.						Extended immersion.
	Cultures from capped cells.			Cultures from uncapped cells.			Cultures from capped cells.			Cultures from uncapped cells.			
	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	
Izal 1 Water 300	+	+	+	+	+	+	+	+	+	+	+	+	6 days
" 1 " 200	+	+	+	+	+	+	+	+	+	+	+	+	+ + +
" 1 " 100	+	+	+	+	+	+	+	+	+	+	+	+	+ + +
Izal 1 Water 50 / Alcohol 50	+	+	+	+	+	+	+	+	+	+	+	+	+ + +
Izal 1 Alcohol 100	+	+	+	+	+	+	+	+	+	+	+	+	18 days
Izal 1 Alcohol 400	+	+	+	+	+	+	+	+	+	+	+	+	+ + +

Note: + indicates growth of *B. larvae*
O " no growth " "

rowth of *B. larvae* in every case with an ccasional contamination of mould or other pecies of bacteria usually either a spore-orming rod or a coccus.

The infected larval scales from the untreated control comb were hard, horny and shrunken and difficult to remove from the cells while the scales from the treated comb were very soft, pulpy and swollen and very easily removed from the cells. This was considered to indicate that the disinfectant had thoroughly permeated the scales.

In both cases immense numbers of *B. larvae* spores were present in the scales as demonstrated in microscopical water mounts made at time of making the cultures.

CONCLUSIONS — Izal is not effective in killing the spores of *B. larvae* as they occur in larval scales in infected combs even after eighteen days' immersion at room temperature.

(Seeing that carbolic acid has been previously shown to be non-effective against *B. larvae* spores even after a month's immersion, it would appear that the coal tar product disinfectants in general are useless for combatting American foulbrood).

Tests with Chlorazene

Chlorazene (Para-Toluene-Sodium-Sulphochloramide) Dakin's new antiseptic and surgical disinfectant is listed as having a phenol coefficient of 50 plus. Its use is mainly in connection with surgical work where it is used in dilutions of 0.1 to 1.0 per cent.

Although its use as a general disinfectant has not been recommended it was thought worth while to test its effect on spores of *B. larvae* as they occur in infected bee combs, consequently a one per cent solution was prepared and an infected comb immersed in this for twenty-four and forty-eight hours after which cultures were made as above described. The results are given in Table II.

After the period of immersion the larval scales were soft, pulpy, swollen and much lightened in colour and easily removed from the cells. Before immersion they were hard, horny, shrunken and difficult to remove from the cells.

CONCLUSION—Chlorazene, one per cent solution in water, is not effective in killing spores of *B. larvae* as they occur in larval scales of infected combs in forty-eight hours immersion.

Tests with Be-Health

Be-Health is said by its manufacturers to be "a special hypochlorite prepared particularly and only for foulbrood of bees".

As chlorazene, a chlorine derivative, was shown by the above experiment to be non-effective against spores of *B. larvae* it was considered to be worth while testing this hy-

TABLE II.

	Combs immersed 24 hrs.						Combs immersed 48 hrs.					
	Cultures from capped cells.			Cultures from uncapped cells.			Cultures from capped cells.			Cultures from uncapped cells.		
Disinfectant	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
Chlorazene 1, water 99.....	+	+	+	+	+	+	+	+	+	+	+	+

Growth of *B. larvae* was obtained in all cultures.

TABLE III

	Combs immersed 24 hrs.						Combs immersed 48 hrs.					
	Cultures from capped cells.			Cultures from uncapped cells.			Cultures from capped cells.			Cultures from uncapped cells.		
Disinfectant	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
Be-Health (full strength)	+	+	+	+	+	+	+	+	+	+	+	+

Growth of *B. larvae* was obtained in all cultures identical with that obtained on cultures made from the control untreated comb.

pochlorite solution, commercially known as Be-Health, on American foulbrood infected combs.

Accordingly infected combs were immersed in Be-Health, full strength, for twenty-four and forty-eight hours respectively after which cultures on test-tube slopes of egg-yolk yeast agar medium were prepared as above described. The results are given in Table III.

The action of the solution on the wax cell walls of the comb was very injurious. These were badly bleached and made friable, causing them to crush very easily when the comb was handled.

CONCLUSIONS — Be-Health is not effective in killing the spores of *B. larvae* as they occur in larval scales of infected combs in forty-eight hours' immersion.

Seeing that neither Chlorszene nor Be-Health (both chlorine derivatives) showed any destructive effect on the spores of *B. larvae* it would appear that chlorine derivatives in general, though most excellent disinfectants in many other connections, are of no use for treating American foulbrood infected combs.

Tests with Formalin

Formalin is the commercial aqueous form of formaldehyde. It should contain 37 per cent formaldehyde gas dissolved in 51 per cent water and 12 per cent wood alcohol.

For disinfection purposes it is frequently vaporized in tightly closed chambers. The articles to be treated are shut in the chamber for twenty-four hours or longer for the formaldehyde gas, generated from the formalin, to act on them. This method of treating combs infected with American foulbrood has been shown in general practice to be of no value as when such treated combs were placed in hives the disease again developed, implying that the spores of *B. larvae* were not killed.

White, however, in 1920 (6) demonstrated that spores of *B. larvae* suspended in aqueous solutions of formalin were killed in a few hours and Dr. Hutzelman in 1922 (7), failed to get American foulbrood to develop in his hives when he introduced infected combs that he had previously immersed for 48 hours in a mixture of 20 per cent formalin in alcohol (the mixture now known commercially as Hutzelman's solution). Alcohol is used instead of water as a diluent in this preparation because of its lower surface tension and greater powers of penetration. Its use, however, makes the preparation somewhat expensive. The questions we wished to decide in the following experiments were, first, whether or not Hutzelman's claims could be substantiated, and secondly, whether or not the use of water as a diluent could be substituted for alcohol with satisfactory results. Accord-

TABLE IV

Disinfectant	Combs immersed 24 hrs.						Combs immersed 48 hrs.					
	Cultures from capped cells.			Cultures from uncapped cells.			Cultures from capped cells.			Cultures from uncapped cells.		
	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
Formalin 100	0	0	0	0	0	0	0	0	0	0	0	0
" 50, Water 50	0	0	0	0	0	0	0	0	0	0	0	0
" 25, " 75	0	0	0	0	0	0	0	0	0	0	0	0
" 20, " 80	0	0	+	0	0	0	0	0	0	0	0	0
" 15, " 85	0	0	+	0	0	0	0	0	0	0	0	0
" 10, " 90	0	+	+	0	0	0	0	0	0	0	0	0
" 50, Alcohol 50	0	0	0	0	0	0	0	0	0	0	0	0
" 20, " 80	0	0	0	0	0	0	0	0	0	0	0	0
Hutzelman's Sol.	0	0	+	0	0	0	0	0	0	0	0	0

ngly combs were immersed for 24 and 48 ours respectively in various aqueous dilu- ons of formalin, alcohol dilutions of forma- n and Hutzelman's solution, after which ultures were made from the larval scales as bove described.

It will be seen from Table IV that in the ase of uncapped cells after twenty-four ours' immersion in all dilutions of formalin sed the spores of *B. larvae* were killed. n the case of the capped cells, however, few of the spores were not killed in this ength of time either in the water dilutions r in Hutzelman's solution.

After forty-eight hours immersion, how- ver, all spores were killed in capped cells as ell as in uncapped cells. Thus, in these xperiments, the water dilutions of formalin roved to be as effective as the alcohol solu- ons in destroying the spores of *B. larvae* as ey occur in the scales of infected brood ombs.

Washing the Formalin from the Treated Combs

On removing the combs from the formalin ilutions strong odour of formalin persisted n the combs for days. As this odour is rongly objectionable to bees attempts were ade to get rid of it. The method that gave est results was washing the combs under e water tap immediately on removal from the formalin. The combs should be held in a slanting position and passed backwards and forwards and from side to side under the free flowing tap. In this way all traces of the formalin can be readily and easily removed, after which the combs are stood up to dry.

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Factors Influencing Strawberry Production.*

M. B. DAVIS

Central Experimental Farm, Ottawa.

The discussion of factors influencing strawberry production could include marketing problems, varieties, disease control and general cultural practices. It is not the object of this brief paper, however, to consider all the various influences which control our production of this most popular fruit. It is more a consideration of fertilizer and cultural treatment necessary for the maximum production of first-class fruit.

We have had very little information given us in the past which was based on experimental results and the next few years should see some fairly rapid strides in the understanding of the fertilization of the strawberry. The information given here is based mainly on the results of several years' work in studying the strawberry crop at Ottawa and, although it can only be considered as preliminary, is indicative of the treatment to be recommended.

First let us consider the new plantation which is to be set out next spring. In this country most of our strawberries are grown in the matted row system and the formation of runners from the plants originally set is the important factor influencing next year's crop. Before dealing with the preparation of the land at planting time and the fertilizer treatment to be given, let me take up the role of the runners in our next season's crop. Shortly after we set out our plants in spring runners or new plants commence to be formed and by autumn we have a whole mat of plants in the row of varying ages. Some (only a few) were formed or rooted perhaps in early July, more in August, still more in September and still more again in October. This is obviously what we should expect, because as the plantation gets older there are more plants to form runners. From a test we conducted we got some idea of the proportion of runners formed on different dates. These figures, which I am going to quote, will of course vary from year to year and on different soils, but the relationship should remain approximately the same. In the test referred to we found by staking that 7% of the runners were formed in July, 24% in August, 30% in September and 39% in October. But when we came to consider where the crop came from we found that, although 39% of the runners were formed in October, they only produced 19% of the total crop, whereas the 24% of the runners formed in August produced 34% and the 30% of runners formed in September produced 39% of the total crop. Obviously the late formed runners do not give as large yields as the earlier formed ones. This is, of course, what we would expect and what we have always known, but we are able here to impress it more fully on your mind by a comparison of accurate counts of some thousands of plants of known age. Knowing then that the early formed runners make far more profitable returns we should consider our treatment of the strawberry patch for the first year in the light of this knowledge. What can we do to encourage the formation of early runners? When have we a full stand capable of giving a maximum crop? Should the late formed runners be allowed to grow, or should they be destroyed?

To answer or even consider these questions we must discuss planting distances, planting dates and methods, soil types, manurial or fertilization treatment and cultivation.

Planting distances have a good deal to do with ultimate yield. Wide rows with plants set a long distance apart in the row have of necessity too large a percentage of late formed runners if a full stand is obtained. In narrow rows where the plants are set fairly close together it is possible to obtain a full stand fairly early in the season and then keep the late formed runners cut off. This means a larger percentage of early runners with a subsequent higher yield. A large number of narrow rows will, therefore, yield more than a smaller number of wider rows. Three to three and one-half feet apart is

* Paper read before the Quebec Pomological Society, December, 1924.

nple and the distance of plants in the row ll, of course, vary with the runner making ility of the variety. The number of plants quired to give a full stand has been shown experiment to be about four to the square ot for maximum results. In this summer's ork we were able to obtain that number the first week in September when two feet is accepted as the width of a row of plants. hen this number of plants is reached it ould pay to cut off as many as possible of e runners formed afterwards, as overcrowdg of the plantation by late formed plants detrimental to the following year's crop. nder ordinary conditions I imagine about the tter part of September would be the date commence to prevent runner formation.

We now come to the question of the most itable soil and soil treatment to obtain the rgest number of early formed runners. As r soil, a loam soil is certainly the most sirable and even a soil that is very light preferable to one that is liable to bake. n the lighter soils it is possible for runners root immediately without being whipped ound for days and weeks before they can nd an opportunity to get a foothold.

In the past recommendations have been to anure heavily for strawberries and, although ey require plenty of plant food, our relts indicate that less manure can be profitly used than we had formerly thought. As e early formation of runners is of paraount importance it becomes essential that ere be an available supply of nitrogen prent in the soil at the time when the plants e ready to commence runner formation. In der to determine the best time for nitron application during the bearing year we d a number of plots laid out in land which d been manured the previous spring and en cropped with roots. No manure was plied to the major portion of the area, pendence being placed on the use of nitronous fertilizers. The plots which received fertilizer whatever formed runners as pidly and in as large numbers as those nich received fertilizer. The manured plots d some of the fertilizer plots actually had orer stands on September 1st than the unrtilized plots. Now we must remember at this land, although a very light sand, d been heavily manured the previous year d that although a crop of roots had been moved there was evidently a large supply of nitrogenous material in the soil, so that nitrogen did not become a limiting factor. Unless the nitrogen content of the soil was depleted we would not expect much results from the use of nitrogen. One thing which stood out, however, was that the plants when set out were incapable of utilizing a readily available supply of nitrogen and in many instances nitrogen applied at that time resulted in injury to the newly set plants, even though the fertilizer did not actually come in contact with the foliage. Our conclusion in this respect was that the concentration of the soil solution had been increased to too great an extent for unestablished plants. When applied one month after planting the nitrogen did not have any injurious results and this would seem to be the earliest date at which applications of quickly available nitrogenous fertilizers can be recommended where the condition of the soil requires that additional nitrogen be supplied during the planting year.

To return to the plots manured in the spring of planting, here growth was poorer than on any plots. This is quite contrary to our expectations, but there is an explanation when one stops to consider. Heavy applications of manure cause poorer moisture conditions in the soil for a time and make it more difficult for the young plants to become established; in fact this condition appears to last for some length of time. We learn from this then that strawberry land is better manured the year previous and that if heavily manured there is in an average soil, enough carry-over effect to make manuring during the spring of the planting year unnecessary. If nitrogen, which is the most unstable of the elements, is lacking it would be better to apply it in the form of a readily available nitrogenous fertilizer, about four to six weeks after the plantation is set out. If the plants are making satisfactory growth and start forming runners well by July 1st it will probably not be necessary to apply nitrogen at this date, but to defer the application until about August 1st.

This brings us to a discussion of the role of nitrogen in increasnig yield. We have seen that early runners give the largest yields; that early runner formation should be encouraged by early planting, good soil, plenty of available nitrogen and by good cultivation. Now it remains to do what we can to further

the formation of fruit buds in these early formed runners. The strawberry plant begins to lay down fruit buds within a very short time of being formed; just how short a time we do not know definitely, but from our work it appears that there are indications of fruit buds being formed in plants that are two weeks old. This being the case it is evident that the plants have formed their buds for next year's crop before winter sets in and anything that we are to do to increase that crop, by increasing the number of berries, must be done before the fruit buds are all determined. Of course a single plant keeps on laying down fruit buds because the crown keeps on increasing with age, so that there is quite a long period over which we can hope to influence next season's crops and that period, as far as we know now, is from about August 1st to October 30th. During this period it is essential that cultivation be continued and that there be a readily available supply of nitrogen. On soils well supplied with decaying organic matter there will probably be sufficient nitrogen if cultivation and moisture conditions are properly maintained so that it may become available. On soils deficient in nitrogen an application of a readily available nitrogenous fertilizer, about the middle of August, at the rate of two hundred lbs. per acre, would prove beneficial. Just when and when not to use this is a question of judgment, for unless nitrogen is a limiting factor in the soil results cannot be expected from an application of fertilizer and, at the same time, I may say that our results have shown by actual count that fairly large quantities of nitrogen may be applied at this time, even on soils well supplied with nitrogen, without reducing the crop.

Nitrogen Applied in Spring

If August applications of fertilizers can increase the crop by increasing the number of fruit buds laid down, what will spring applications of nitrogen do? This question is one full of controversy and our results so far have not entirely borne out the results of some other experimental stations. It has been said that spring applications of nitrogen actually suppress the development or cause the abortion of buds. To test this out we made nitrogen applications to plants growing on soil in which we knew nitrogen had not been a limiting factor. We knew the parentage and age of every runner in all the plots and we counted one by one the flower stalks, primary buds, secondary, etc., with the result that we found just as many buds produced on the fertilized plots as on the unfertilized. The differences were well within the probable error. In this case, at least, our spring applications of nitrogen did not cause a reduction in the number of fruit buds developed and from our knowledge of the fruit bud differentiation period we did not expect an increase.

We did, however, expect results from our spring applications of nitrogen by obtaining increased sized fruit and a better set. The results, although not as marked as they probably would have been on poorer soil where nitrogen would have been a limiting factor, indicate that spring applications of nitrogen tend to increase the size of fruit and give a better set. In actual figures we obtained a 7% better set on the nitrogen plots than on the unfertilized plots and an increase in size of fruit, due to the nitrogen, of from 7% to 44%, depending upon whether or not we were dealing with primary, secondary or tertiary fruits. We are forced to conclude, therefore, that on normal soil our spring application did not reduce our crop by a reduction of numbers, but did tend to improve its quality and quantity by an increase in size of the fruits and an increase in the set.

In closing then let me briefly say that to obtain maximum results from a strawberry plot you should:

(1) Manure the year previous to planting.

(2) Plant early in spring, using good, strong, healthy plants.

(3) Use a large number of narrow rows in preference to wide ones.

(4) Encourage early runner formation by cultivation and the use of nitrogen where necessary, being careful to apply it not earlier than one month after planting.

(5) Keep the late formed runners removed as soon as a full stand is obtained, which is when there are about four plants to the square foot.

(6) If there is any danger of nitrogen being a limiting factor apply a quickly available nitrogenous fertilizer during August to encourage fruit bud formation.

(7) Light applications of nitrogen in spring will increase size of fruit and give a better set.

Fertilizer Tests With and Without Ground Limestone.

W. S. BLAIR

Superintendent, Dominion Experimental Station, Kentville, N.S.

This test was started at the Experimental Station, Kentville, N.S., in 1914, and has been continued since that time. The plots are 33 by 66 feet, or one-twentieth acre each. The object of the experiment is to determine the most profitable source of nitrogen and phosphorus. On a similar series of plots ground limestone was applied for the purpose of gaining information as to its value under such fertilization and soil management. Both series of plots were duplicated, and the results given are the average of two plots.

The area was apparently uniform at the start of the test and was described at that time as a sandy loam low in fertility and deficient in lime. It had been cleared in 1912, and after breaking was seeded early in July to buckwheat, which was plowed under in the fall. No manure was available in 1913, and the area was fertilized at the rate of 400 pounds per acre with a mixed fertilizer containing 4 per cent of nitrogen, 8 per cent of phosphoric acid and 10 per cent of potash. Longfellow corn was planted, and the yield of green corn was 4 tons, 100 pounds per acre.

The permanent plots were started in the spring of 1914. A three-year rotation of potatoes, grain, and clover and timothy hay has been followed. Though varied in respect to the materials used the same amount of plant food elements has been added to each plot fertilized; viz., 21 pounds of nitrogen, 48 pounds of phosphoric acid, and 50 pounds of potash per acre, at the start of each rotation. It was soon evident that for this type of soil this amount of plant food was not sufficient to support three productive crops, and at the conclusion of the first rotation, in the spring of 1917, uniform stable manure at the rate of 15 tons per acre was applied to each plot, including the check or unfertilized plots. Since that time only the chemical fertilizers as stated have been used. The limestone was applied to the limed areas at the rate of 2 tons per acre, also at the commencement of each rotation. The fertilizers used and the rates per acre are shown in the table below. The production from these plots is given in the table at the top of the follow page.

Plots 1 and 2 are comparable, for here we have a test between nitrate of soda and sulphate of ammonia, the plots otherwise being treated alike. With respect to sources of phosphoric acid, plots 3, 4, and 5 are comparable. This table furnishes data of considerable interest and would go to show that if the lime requirements of plants are met, the source of the various fertilizers makes little difference. The difference in yield between the limed and unlimed areas, and the profits per acre are quite striking.

Plot	Nitrate of Soda (15%N.)	Sulphate of Ammonia (20% N.)	Acid Phosphate (15% P_2O_5)	Basic Slag (16% P_2O_5)	Bone Meal (22% N, 22% P_2O_5)	Muriate of Potash (50% K_2O)
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	140		150	150		101.2
2		105	150	150		101.2
3	70	52½	300			101.2
4	70	52½		300		101.2
5	50	52½			240	101.2
6	No fertilizer					

	Plot	Potatoes 1914-17-20-23 Total yield	Hay 1916-19-22 Total yield	Wheat 1918-21 Total yield		Oats, 1915 Total yield	
				Grain	Straw	Grain	Straw
		bushels	lbs.	bushels	lbs.	bushels	lbs.
1.	Limed	791.2	9,640	44.4	4,920	37.9	2,200
	Not limed ..	725.8	4,630	34.5	3,430	32.6	1,970
	Gain	65.4	5,010	9.9	1,490	5.3	230
2.	Limed	743.1	9,000	44.3	4,700	38.5	2,250
	Not limed ..	690.7	4,290	31.5	2,810	29.1	1,590
	Gain	52.4	4,710	12.8	1,890	9.4	660
3.	Limed	788.5	9,270	45.2	4,640	36.9	2,115
	Not limed ..	734.	4,520	31.6	3,110	31.8	1,785
	Gain	54.5	4,750	13.6	1,530	5.1	330
4.	Limed	819.4	10,450	48.5	4,520	40.4	2,405
	Not limed ..	738.3	4,840	34.4	3,530	31.1	1,900
	Gain	81.1	5,610	14.1	990	9.3	505
5.	Limed	792.1	9,360	45.2	4,910	38.2	2,020
	Not limed ..	702.1	4,590	35.3	3,750	33.6	1,845
	Gain	90.	4,770	9.9	1,160	4.6	175
6.	Limed	652.4	7,300	41.9	3,950	32.7	1,575
	Not limed ..	557.4	4,020	28.3	3,270	30.4	1,615
	Gain	95.	3,280	13.6	680	2.3	–40

It should be pointed out that while potatoes are in some respects a good crop for fertilizer tests, yet where lime is used as continuously as in this test the potatoes on the limed areas are of no value for market. With the application of manure in conjunction with limestone scab development was rapid, and on the limed areas there were practically no tubers free from scab. The unlimed areas on the other hand were practically free from scab. Lime does not directly benefit the potato crop, the apparent gain being due to the residue left in the soil by the clover roots. We are convinced that the rational thing is to set aside certain areas best suited to potato culture, and from these to withold lime entirely. We advise that lime be applied when seeding to grain, clover and timothy, and not to the hoed crops, as then the clover receives more direct benefit. The difference in the limed and unlimed areas is decidedly marked at the present time, particularly with respec to the production of hay, the unlimed are consistently producing no clover, except o the slag plots.

In arriving at the value of the crops on th different areas, potatoes and oats have bee valued at 60 cents per bushel, and wheat a $1.00, hay at $12.00 and straw at $7.00, pe ton. It is but fair to state that for feedin purposes the hay on the limed plots had ap parently double the feeding value per ton o that from the unlimed areas. However i this calculation the same value has been allow ed in each case. The fertilizer is charged pe ton at the rate of $60.00 for nitrate of sod $20.00 for acid phosphate, $40.00 for muriat of potash, $24.00 for slag, $80.00 for su phate of ammonia, $48.00 for bone meal, an $4.00 for ground limestone. A summary o results for nine years, 1914 to 1922 inclu sive, is given in the following table:

Plot	Total value of crops, per acre	Total value of gain over untreated plot, per acre	Total cost of gain, per acre	Total profit per acre
1. Limed	$514.28	$149.50	$52.56	$96.94
Not limed	449.52	84.74	28.56	56.18
2. Limed	498.76	133.98	52.56	81.42
Not limed	431.43	66.65	28.56	38.09
3. Limed	517.94	153.16	51.66	101.50
Not limed	445.20	80.42	27.66	52.76
4. Limed	542.60	177.82	53.46	124.36
Not limed	452.46	87.68	29.46	58.22
5. Limed	517.05	152.27	58.14	94.13
Not limed	424.73	59.95	34.14	25.81
6. Limed	443.20	78.42	24.00	54.42
Not limed	364.78			

Conclusions

1. Nitrate of soda gave slightly better returns than sulphate of ammonia, per unit of nitrogen applied.

2. On the unlimed plot where sulphate of ammonia is used the natural flora indicates increased acidity.

3. The slag plots have given slightly better returns than the acid phosphate plots. The stand of clover on the slag plots has been noticeably better. Where no lime was used slag has given better hay and grain crops than acid phosphate.

4. Limestone is apparently of greatest benefit to the hay crop, particularly clover. Wheat responds in a marked degree. Oats may be grown successfully on decidedly acid soils.

5. Limestone applied once in three years over a period of three rotations has developed serious scab conditions. The unlimed areas are free from potato scab.

6. Limestone should not be applied to a potato crop. To apply when seeding down to grain is advisable.

7. Limestone has more than doubled the hay crop, and given hay of a better quality. Its greatest value in agriculture is due to the fact that by its use clover can be grown on certain soils which otherwise would not grow this crop.

C. S. T. A. Forum

This section has been introduced in *Scientific Agriculture* in order to publish communications from C.S.T.A. members dealing with matters of professional interest, and also for the publication of subsequent discussion of such matters. It is hoped that members will take full advantage of the opportunity thus offered of bringing their views to the attention of the profession, and in this way promoting interesting and helpful discussion. The names of correspondents will be omitted if desired. but must always be furnished to the General Secretary.

The letter published below, dealing with a problem of great interest, is the first to be published, and will give an idea of the type of material desired.

Unless this section of the magazine is supported by the members, it will have to be abandoned at once. Please address all communications to the General Secretary, C.S.T.A., Ottawa, Ont.

DUPLICATION

A a conference recently held at Ottawa, at which Federal and Provincial Ministers conferred on matters pertaining to taxation and expenditure, one of the resolutions passed was that, at a future conference, the matter of duplication of provincial and federal services should be considered. No public announcement was made as to specific instances of duplication which the members of the conference had in mind but it is understood that, in the discussion which took place, the services of the Departments of Agriculture came strongly to the front.

This leads the writer to say that, whether it is true or not that there is duplication, the fact that Ministers of the Crown believe that there is duplication either establishes the case or points to the necessity of those engaged in the service of agriculture getting together. The criticism must either be refuted or plans must be made to remove any foundation for such criticism.

The writer, who has been identified with agricultural departmental work for upwards of twenty-five years, is bound to say that during all that time he has heard complaints both from federal and provincial officers that the work which they were attempting was being unfairly appropriated by one or other of the departments concerned. Often, these complaints proved on investigation, to be based mainly on individual jealousies. In fact, the writer has recollections of such issues being solved either by a meeting of the officers concerned, or by the effecting of such a change of officers as to throw into the same field men of compatable natures. In this connection, the C.S.T.A. has, to our personal knowledge, given valuable service, in that it has afforded the best medium that has yet been offered for the meeting together of men in all branches of the agricultural service both provincial and federal.

It is a debatable question, however, whether a system of administration should continue that causes so much difference of opinion respecting policy and consequent overlapping and unnecessary duplication of effort. We believe that it was a wise provision of the British North America Act that there should be joint jurisdiction of the Federal and Provincial Governments in matters pertaining to agriculture, but we also believe that in the interests of the conservation of public expenditure, more careful consideration should be given to this realm of service and a strong effort made to define more exactly just where either federal or provincial service should end.

We have ourselves heard more than one Minister of Agriculture state that it would be his aim to stop duplication and effect a greater measure of co-operation between the Federal and Provincial Departments of Agriculture. We have seen considerable accomplished along this line but we believe that there is need for a more careful investigation of the whole matter than has yet been made, with the object of offering a clear definition of the limits of service of the respective departments.

An investigation of this kind might be made by bringing together, for conference purposes, officers of the Provincial and Federal service who could mutually discuss the various branches of work and endeavor to arrive at a clearer definition of what should be their respective activities. We have seen such conferences attempted before when the subjects involved were not by any means as far-reaching as the subject with which we are now dealing. While we have seen some progress made at such conferences, yet we have seen too many of these meetings break up with the differences just as far from being solved as when the conferences were first summoned. So much has this been the case that we ourselves have not much confidence in a conference.

We do, however, offer a solution to this problem which we present if for no other reason than to open up the columns of *Scientific Agriculture* to discussion. It is that a Commission, (we know that many such are in disrepute) composd of, say, one widely experienced administrator from some other country, such as the United States, two experiencd men to be selected by the Federal government and two by the Provincial governments, be appointed to enquire into this whole question. Such a commission should be allowed ample time in which to do its work. It should go from province to province and from office to office and as far as possible try to obtain such evidence as would be given by men in their own offices where the actual facts are much more likely to be discovered than in any formal court of inquiry at which numbers of witnesses are called upon to give evidence.

After this Commission had completed its investigations, it is quite possible that its recommendations might wisely be of a tentative character. They might to advantage be submitted for discussion to officers of the Federal and Provincial Governments assembled at a conference to deal with this matter. Some such procedure prior to the submitting of a final report would in all likelihood lead to more effective recommendations than might be made if the Commission were merely to investigate and bring in its report without hearing the subject discussed at a conference in which various opinions would be represented.

It must be admitted that the working out of this solution will represent the expenditure of considerable time and money. However, the subject is one of great importance, and if a better basis of co-operative working were arrived at, than now exists, conservations of money and effort should be effected that will more than pay for all the expenditure involved.

(Reference No. 101)

Concerning the C.S.T.A.

HIGHER PENSION PROPOSED FOR DR. SAUNDERS

According to a press statement on January 15th, a resolution will be submitted at the coming Session of the Dominion House of Commons, to increase the pension of Dr. Charles E. Saunders, formerly Dominion Cerealist, from $1200 to $5000 per annum. The resolution will be sponsored by Mr. John Millar, Progressive M. P. for Qu'Appelle, Sask.

Dr. Saunders occupied the position of Dominion Cerealist from 1903 until 1922 and his researches produced useful varieties of wheat and oats, including Marquis wheat which has been a source of millions of dlolars to Western farmers. For the past two years Dr. Saunders has been studying at the Sorbonne in France and returned to Ottawa three months ago.

PROFESSOR OF AGRICULTURE FOR AUCKLAND UNIVERSITY COLLEGE.

The attention of C.S.T.A. Members is directed to the advertisement on the opposite page calling for applications for the position of Professor of Agriculture at the Auckland University College, Auckland, N.Z., at an initial salary of £900. This is the first step towards the establishment of a School of Agriculture.

The Professor will be required to organize the School and to give and direct theoretical and practical instruction for all divisions and grades of the subject. Applications from Canadians will be referred to a Canadian Committee composed of Dr. J. H. Grisdale, President J. B. Reynolds and the General Secretary of the C.S.T.A. who will in due course forward their recommendations to the Registrar of the Auckland University College.

APPLICATIONS FOR MEMBERSHIP

Brown, W. R. (Alberta, 1923, B.S.A.) Edmonton, Alta.

Danielson, H. F. (Manitoba, 1915, B.S.A.) Arborg, Man.

Evans, J. H. (Wales, 1923, B.Sc.) Winnipeg, Man.

Morton, B. W. (Toronto, 1921, B.S.A.) Ponce, Porto Rico.

Reoch, John, (Saskatchewan, 1924, B.S.A.) Regina, Sask.

Stewart, K. E. (McGill, 1924, B.S.A.) Ottawa, Ont.

NOTES

The Annual meeting of the Macdonald branch will be held at Macdonald College on February 19 and 20. Copies of the programme will be mailed to local members, and other interested members can obtain copies from the Secretary, E. A. Lods, Macdonald College, P.Q.

G. C. Hay (Macdonald '16) has been appointed Live Stock Commissioner for British Columbia. He was formerly District Agriculturist at Kamloops, B.C.

G. A. Scott (O.A.C. '23) has been appointed to the staff of the Dominion Laboratory of Plant Pathology, Saskatoon, Sask.

Dr. G. C. Creelman is spending the months of February and March in the south and will return to his farm at Beamsville on April 1st.

Plans are now being made for the Fifth Annual Convention of the C.S.T.A., to be held at the University of Alberta, June 24-26, 1925. The final programme will be sent to all members about the end of May.

The second re-union of Macdonald College graduates will be held in June, 1926. This date has been decided upon because it coincides with the Sixth annual meeting of hte C.S.T.A., which will be held in one of the eastern provinces in 1926.

Availability of Organic Nitrogenous Fertilizers.

(A RESUMÉ)

W. A. DE LONG

Macdonald College, P.Q.

In respect of availability nitrogen occupies unique position among the ordinary fertiliz- ng elements. The readiness with which com- ounds of phosphorus and potassium can be tilized by crops is dependent almost entire- y upon their solubility in water, or the dilute nd slightly acid solutions present in soils. Water soluble forms of nitrogen, however, nay be positively toxic to some plants while apable of assimilation by others, or they nay be non-toxic and non-available as well. Again, nitrogen in the multifarious forms in vhich it may be applied varies greatly in fficiency in supplying the needs of plants. Further, nitrogen compounds differ from hose of phosphorus and potassium in that he changes which they undergo in the soil nd their availability to plants are modified o a much greater extent by the activities of iicro-organisms. Availability of the nitro- enous fertilizers then is by no means as imple a consideration as the availability of he fertilizers supplying the other commonly ecessary plant food elements.

The question of the determination of the eadiness with which such fertilizers yield heir nitrogen for use by plants first assumed mportance with the advent of the mixed ertilizer. So long as nitrogenous materials ere sold singly on their own merits, and un- er their own names and descriptions, there as little need for the testing of commercial aterials used as a source of this element, nce their *relative* availability has been well nown to agriculturists for a long time. Com- iencing with the use of guano, however, the rmer became accustomed to the idea of urchasing materials of origin foreign to the rm, and of the nature of which he knew ttle. Then when the supply of guano be- me insufficient to meet the demand, it be- me a common practice among the more scrupulous of the fertilizer dealers of the me to adulterate the guano with other and ually cheaper materials, singly or in mix- res, singly or in mixtures, in order that the demand for this popular form of plant food might be met. Gradually the typical mixed fertilizer of today was evolved, in which the origin and nature of the components are exceedingly difficult or impossible of detection. Owing to the difficulty of determining the constituent materials, and the further fact that if the mixture possessed the outward characteristics of guano such as color and odor it found a ready sale (at first at least), unscrupulous dealers became very lax in the choice of the ingredients used so far as availability was concerned. It soon became evident that some form of legal protection was needed in order to save the farmer from exploitation. With the establishment of laws in regulation of the fertilizer trade the adoption of specific tests for the availability to plants of the various elementary plant nutrients in the ingredients used became imperative. Thus came into being the large number of more or less satisfactory methods which are existent to-day for this purpose.

With respect of the element nitrogen the availability of the inorganic compounds of this element is in a general way fairly well known. It is only in the case of the many organic forms and principally those of natural origin that availability tests have an extensive use. The various methods which have been evolved for this purpose may be classified as vegetation and laboratory tests.

Vegetation Tests

In determining the availability of organic nitrogen by such methods the material in question is tried out directly upon the crop plant or plants for the use of which it is to be applied. The results of such tests are, of course, the final criterion by which the usefulness of any fertilizer must be judged, since the particular plant involved answers directly. In practice, however, every crop must be tested individually, and so must every soil. This renders the method onerous, extremely expensive and time-consuming. It is also

highly impracticable, so far at least as fertilizer inspection and regulation are concerned. For this latter purpose an estimation of the availability of the material in question must be made within a time limit of days, or at most weeks, insteads of the months or years required for a dependable verdict using the method of vegetation tests. Hence the necessity for the laboratory test, which is aimed at the attainment in as short a time as possible of as close an approximation to the verdict of the plant as can be arrived at. Laboratory methods, of course, must be supplemented with and calibrated or standardized by vegetation trials.

Laboratory Tests

The methods in use in the laboratory for the determination of the availability of organic nitrogen may also be subdivided into two groups, namely:

Those comprising strictly chemical methods such as pepsin-hydrochloric acid digestion, and the alkaline and neutral permanganate methods.

Those which are bacterio-chemical in character such as the ammonification and nitrification methods.

While efforts have been made over a considerable length of time to determine the availability of organic nitrogen by chemical means, such methods were first brought to general attention about the year 1910. The experiment stations of the New England States published a pamphlet on the subject in March 1911. This pamphlet was entitled "A Method for the Examination of the Activity of Organic Forms of Nitrogen", and contained instructions for the carrying out of the alkaline permanganate method together with results from its use obtained by the seven experiment station laboratories concerned upon a nitrogen fertilizer of a low grade. This was the first instance of the grading of the quality of organic nitrogen by chemical methods established by law, and this particular method was largely the outcome of work done at the Vermont Agricultural Experiment Station by C. H. Jones.

The neutral permanganate method as used at present is largely the outcome of the work of J. P. Street and J. E. Breckenbridge. It was at the suggestion of the latter that t addition of sodium carbonate to the perma ganate solution previous to the addition of t fertilizer was adopted. This has been foun to ensure better results for organic nitroge ous materials such as blood meal and tanka when present in mixtures containing ac phosphate, the presence of which tends lower their solubility in permanganate sol tion alone. The neutral permanganate met od as outlined by its inventor was adopted the state chemists of South Carolina, Georgi Alabama, Florida and North Caloina, in se sion at Atlanta on November 2nd, 191 Originally it was required that the resul obtained by the neutral permanganate metho as adopted by these Southern states should l checked against those obtained by the pepsi hydrochloric acid method. The latter ha now become obsolete, however. According t the Fertilizer Act of 1922 the alkaline pe manganate procedure as modified at the su gestion of Breckenbridge is the method pr scribed for the estimation of the availabilit of organic nitrogenous materials in Canada.

The details of the operation of both th neutral and alkaline permanganate metho are, of course, given in the book of metho of the American Association of Official Agr cultural Chemists and need not be recounte here. Some space may, however, be devote with advantage to the mention of some of th criticisms of these methods which have bee advanced. The two chief points on whic fault has been found with the alkaline pe manganate method are:

That tne results with certain material such as cottonseed meal, which have bee demonstrated to give good results in th field, do not show them to possess thi vavlue.

That it is so difficult to duplicate result by this method that a high degree o skill and experience are required for it operation.

With regarn to the first objection it ha been found that when the prescribeh amoun of sample is taken, such materials decolorize the permanganate solution due to the larg amount of carbonaceous matter present. When however, such an amount of sample is take that the permanganate solution is not decol orized, the "activity", or availability, agree

etter with the field performance. Respecting the second objection, the difficulty in luplication is chiefly due to the high concenration of reagents at the end of the distillaion period, which entails a correspondingly iigh speed of reaction at this stage, and causes mall variations in the time of distillation to give considerable variations in the results obained. Close attention to this factor will hen enable the operator to secure more consistent checks in the use of this method.

The necessity of paying close attention to certain other factors has also been pointed out. Foremost among these is the washing out of the water-soluble nitrogen. This must be very thoroughly done, and it has been found too that the grade of filter paper used during this operation may have a very important effect upon the result obtained. It is stated in addition that the *digestion* with the alkaline permanganate should be carried out at a temperature below the distillation point of the mixture, and the temperature subsequently *gradually* raised to the distillation point in order to obtain best results.

The neutral method has also been criticized on the ground that it does not give results in as close accord with the field performance of organic nitrogenous materials as does the alkaline method. It has however, shown by a long series of tests differentiation between materials of high and low availability, and is, in addition, simpler of operation than is the alkaline method. These facts have led to the adoption of the method in Canada and in several of the Southern states.

Bacterio-Chemical Methods

There are two of these which are based upon the conversion of nitrogen from the complex forms in which it occurs in organic substances either to ammonia or to nitrates through the activities of the micro-organisms of the soil, principally the soil bacteria. In the application of such methods to the estimation of the availability of the nitrogen in organic nitrogenous materials an arbitrary amount of the substance to be tested is taken and mixed with an arbitrary amount of soil; the whole is maintained at the temperature and moisture content which have proven best suited to the activities of ammonifying and nitrifying bacteria under laboratory conditions for an arbitrary length of time, and the amounts of ammonia or nitrates produced determined by chemical means. It is considered that the amounts of ammonia and nitrates found at the end of this incubation period will be a direct indication of the relative availability of the material tested.

Such methods may be criticized from several points of view. For example, the fundamental assumption that the rapidity with which the nitrogen of the substance is changed to ammonia or to nitrates is a measure of the rapidity with which it will be supplied to plants is not necessarily true since other forms of nitrogen such as paragin and urea may be made use of by plants. Further, the methods which are most commonly employed for the estimation of the amounts of nitrate produced are not beyond criticism. In the determination of ammonia, for example, the usual procedure followed involves distillation with magnesium oxide, and the use of this substance for the liberation of ammonia from solution in the presence of organic nitrogenous materials is, of course, open to error. Neither is the estimation of nitrates by the standard phenoldisulphonic acid method above question, being subject as it is to all the general criticisms of colorimetric methods from the point of view of exactness. Nor is the matter of extraction of the nitrates as simple a matter as it has been regarded.

Advocates of these respective methods also find the procedures employed *by each other* unsatisfactory. For example, proponents of the nitrification method stress the fcat that it is theoretically possible that the relative ammonification of a group of nitrogenous substances may not correspond exactly with their rates of nitrification. Therefore, say they, since plants generally take the greater part of their nitrogen in the latter form, the rate of nitrification is a better criterion of the availability of organic nitrogen than is the rate of ammonification.

Neither is the nitrification method without its critics. As commonly employed, this method is used to measure the amount of nitrates produced from one gram of material in one hundred grams of soil when incubated for a period of four weeks at a temperature of 28 to 30°C. The standard amount of one gram of the material is taken without regard

to its total nitrogen content. It has been demonstrated, however, that the total nitrogen content may have an important effect upon the results obtained. It has also been shown that widely different results may be obtained by variation of the length of the incubation period, and that, when *equal concentrations of nitrogen* are used, that materials of such widely different character as dried blood, bone meal, and ammonium sulphate may be shown to be of equal availability by this method.

Relation of Constitution to Availability

The organic nitrogenous materials of natural origin employed as fertilizers are, of course, principally of a protein nature, and are, accordingly, built up of various combinations of amino acids. The rate of availability of such substances therefore depends, in the first place upon the ease with which such proteins may be hydrolyzed or split up into their constituent amino acids, and secondly, to a large extent upon the rate at which the ammonifying and nitrifying organisms of the soil are able to convert these amino acids to ammonia and nitrates. For example, it has been shown that the benefit derived from "processing" materials of low availability, or digesting them with sulphuric acid, is due to the fact that such treatment results in the more or less complete hydrolysis of the proteins.

The reactions of the second phase have been studied in their bacteriological aspects by various workers employing simple amino acids, acid amides and primary amines. Their results show that the simpler aliphatic amino acids are more readily ammonified than those having longer chains, and that cyclic amines are still more resistant than the latter. Others have found that basic nitrogen is most completely ammonified, and that amide and non-basic nitrogen compounds vary in their availability.

The most comprehensive of the recent work on the mechanism of the chemical tests has been done by Robinson and his colleagues at the Michigan Experiment Station. These investigators have set themselves systematically to the determination of the relations between chemical constitution and availability, and to the devising of a better method of measuring the latter. After considerable manipulation of the alkaline method, they came to the conclusion that more knowledge of the fundamental facts regarding availability was essential before any appreciable progress could be made towards the second of their objectives. They have, however, made sufficient progress to be able to recommend a modification of the alkaline method as used at present, which gives substantially identical results in a much shorter time.

Respecting the more fundamental aspects of their work, these investigators have attempted to determine the effect of alkaline permanganate upon nitrogen in such various forms of combination as, glycine, arginine, lysine, diphenylamine, naphthylamine, urea and acetamide. The general conclusion from this work was that primary aliphatic amino groups were quantitatively ammonified, while amines, cyclic compounds and amino groups in other than the alpha position were ammonified to a lesser extent. From this they argue that the results obtained by the use of this method on a complex material such as a protein would be expected to yield all of the a-amino nitrogen from free amino acids present originally, or formed during the determination, *plus* a variable fraction of the nitrogen from the other nitrogen-containing radicals, *but* since it has been shown that practically all of the free NH_2 groups in native proteins consist of the e-amino groups of lysine, and acid amide radicals of dibasic acids, this variable fraction and the hydrolytic changes upon which it depends, are of the first importance. Under the strenuous conditions of the alkaline permanganate process hydrolysis would be expected to proceed rapidly, but not to completion. If then, the extent to which the hydrolysis proceeds approximates the extent of the formation of available nitrogen in the soil during the growing season, the results obtained by this method are indicative of the worth of the material.

A number of pure proteins and commercial organic nitrogenous materials were also investigated by these workers. The results showed, in the case of the pure proteins, that alkaline permanganate caused the ammonification of *more nitrogen* than that expressed by the total amino nitrogen, but *less than* that equal to the *sum* of the amino and acid amide fractions. Similar relations were in general

ue of the more complex materials of the rtilizer trade. With these latter, however, fifty per cent of the cases hydrolysis was pparently incomplete, assuming that all of e amino acids liberated during acid hydroly- s (by the Van Slyke method) is capable f being ammonified in the permanganate igestion.

The conclusion finally arrived at was that is possible to measure by the alkaline per- anganate method the total amounts of acid mide, and amino acid nitrogen producible om any substance, if treatment be continued ng enough. All of this nitrogen can be sed by plants for food purposes, in some ases directly, and in other cases indirectly fter conversion to ammonia. The great dif- culty lies, however, in the determination of at portion of this potentially available frac- on which will be made available to crops uring the growing season. This, of course, is ependent upon all those many factors which fluence the micro-organic activities of the oil, and the time is probably yet distant hen we shall be able to guage the extent of ich activities between anything but com- aratively broad limits.

The present situation with respect of the etermination of the availability of organic itrogen is very confused. Speaking before e 1923 Convention of the American Associa- on of Official Agricultural Chemists as re- eree on the subject, C. S. Robinson reported at of twenty-eight state experiment stations which enquiry had been made, thirteen did ot determine availability by any method, ne used the alkaline, and three the neutral rmanganate method; three using both hen in doubt. Some laboratories made no ttempt to classify the organic nitrogen if e insoluble part was only a few tenths per nt, and among those which did classify or- anic nitrogen, the terminology used in re- orting the availability was far from uniform. or example, some reported as per cent of *ctive* water-insoluble nitrogen, while others sed different gradings as passed, inferior, c. Similarly, the pass requirements for the eutral method varied considerably, from venty-five to eighty-five per cent. of the ater-insoluble nitrogen being required to soluble in the permanganate solution at fferent stations. The users of the alkaline ethod, however, require 50 per cent "activity" of the water-insoluble nitrogen with but one exception.

At the above meeting the Committee on Terms and Interpretation of Results recommend that:

> The alkaline and neutral methods be used only on mixed fertilizers containing water-insoluble organic nitrogen amounting to one-third or more of the total nitrogen found, and that the nitrogen in such fertilizers be passed as satisfactory if more than two-thirds of the total nitrogen guaranteed is water soluble. The water insoluble nitrogen of such fertilizers are classed as satisfactory when showing an activity of 50 per cent or over by the alkaline, or 75 per cent or more by the neutral method.

In conclusion, it may be of interest to note briefly the degree of correlation which has been found to obtain between the results of chemical tests and vegetation tests. The most extensive work along this line has been done at the Rhode Island Experiment Station under the direction of Hartwell and Pember. At this station one hundred and forty-seven samples have been tested for availability as measured by the growth of oats and millet, as well as for activity by the alkaline permanganate mtehod, and, for more than half, by the neutral method also. Three results have been compared on the following basis:

Nitrogen in nitrate of soda is given a value of 100.

Nitrogen in dried blood is given a value of 70.

An activity of 55 per cent and over by the alkaline, and of 80 per cent and over by the neutral classes a fertilizer as being good.

According to this standard, for the alkaline method there were only four cases, or eleven per cent, in which the activity fell below 55 per cent and the availability of the material as shown by the vegetation tests was above. By the same standards there were eight cases, or 21 per cent, in which the activity indicated a better quality and the actual availability was less than 28. Somewhat similar results were obtained by the neutral method. When both laboratory methods were used not a sample of insoluble nitrogen with an availability of over 55 per cent as shown by vegetation tests was con-

demned by both methods; while in only one case did they both fail to condemn a sample having an availability of less than 28.

It should be borne in mind, however, that in all this work the actual availability to crops was that of these materials to the oat and millet plants only, and their respective availability to other crops may be quite different. For example, varieties of corn have been found to differ in their power of assimilating nitrogenous compounds, peptons being better utilized by dent than by popcorn. Again, in testing the availability of activated sewage sludge at Wisconsin Experimental Station, it was found that 83.5 per cent of the nitrogen content was available to the oat plant, but that the corn plant was able to use only 40.5 per cent.

The estimation of the availability of organic nitrogen is then evidently far from being established on a permanent basis, and it is apparent that there is opportunity for much further research respecting the fundamental principles governing availability tests. There remains also much careful work of a more or less routine character to be done in establishing the availability of different crops of the materials used as ingredients in th manufacture of mixed fertilizers containir organic nitrogenous substances.

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Plant Pathology in Canada.*

B. T. DICKSON
Macdonald College, P.Q.

Tradition is not sufficiently well established to determine whether or not a presidential address shall be given at our Annual Meetings and it was only after much deliberation that I finally decided to give one at the termination of my year of office.

In justification it is suggested that the time is ripe for a written record of the work of the pioneers in our field and I hope that the facts herein given will stimulate some other student to round out and complete the story.

Naturally one's first thought is concerning the scope of the subject indicated. What exactly do we mean by Plant Pathology? As plant science is becoming daily more specialized, it is inevitable that old fields shall be partitioned off into more closely circumscribed areas and one can with a considerable degree of certainty postulate a division of labour so minute that the workers cannot possibly see over their immediate circumscribing fences to the boundaries of the original field. Thus one specializes from Biology through Botany, Mycology and Bacteriology to become finally a Dairy, Medical, Plant or Soil, etc. Bacteriologist. Undoubtedly Plant Pathology is fated to give rise to specialized fields resulting in the investigators becoming Cereal, Fruit, etc. Pathologists—in fact we are now accustomed to the term "Uredinologist", and who knows but soon we may hear of "Viriology" or "Strongyloplasmatology" or some other high-sounding "-ology".

There are rather definite views regarding the scope of our work if one considers the appellations given—for in Great Britain and in Colonial positions the official designation is "Mycologist" (and therefore the "Imperial Bureau of Mycology" and the "Review of Applied Mycology") as compared with "Plant Pathologist" on this continent. I am not at the moment concerned with these official titles as to whether they coincide in meaning with the work expected of the title holder, but I would merely remind you that literally a plant pathologist is one who has to do with plants which are diseased, whatever the etiology of the condition may be.

It is in this broad sense that I am using the term in this address. Before proceeding it is perhaps pertinent to point out, and it is certainly of considerable professional interest, that Dr. A. E. Boycott, Graham Professor of Pathology in the University of London, on the occasion of his address at the opening of the new Pathological Institute at McGill University, presented the view that pathology is a science capable of standing on its own feet and that if medicine and surgery were abolished pathology would go on of itself. He expressed the opinion that there was a fruitful field in the pursuit of pathology in some other animal than man, and indictated that future study along this line should include pathology of plants.

First Publications.

As a result of the ravages of the Hessian Fly between 1846-1856 in Ontario and Quebec, the Government of Ontario offered three money prizes for the best essays on "The Origin, Nature and Habits, and the History of the Progress from Time to Time,—and the Causes of the Progress of the Weevil, Hessian Fly, Midge and such other Insects as have made ravages on the Wheat Crop in Canada; and on the Best Means of evading or guarding against them." The first prize was won by Prof. H.Y. Hind of Trinity College, Toronto, and his essay was published in 1857 under the title "On the insects and diseases injurious to wheat crops." This is the earliest record of a Canadian publication in Plant Pathology so far ascertained. Prof. Hind knew that these diseases were caused by fungi and thus must have been aware of the research of his time. It is necessary only to remind you that DeBary published his "Die Brand Pilze" in 1853, was working on late Blight of Potato in 1861, and on the relation between barberry and wheat rust in 1865, to give an idea of the period. To Ontario belongs the credit for the first publication, but Nova Scotia was not far behind.

* Presidential address at the annual meeting of the Canadian Society of Phytopathology, December, 1924.

In 1866 George Lawson published "Blights and Diseases of Plants" in the Nova Scotian Journal of Agriculture, and in May 1867, John F. Bennett in the same journal wrote "On the cause of rot in grapes, potatoes and other vegetables."

Dr. A. H. Mackay, Superintendent of Education for Nova Scotia and Prof. H. S. Cunningham of the Truro Agricultural College have very kindly supplied me with the following information concerning articles in the N.S. Journal of Agriculture. Bennett was from Pittsburgh and he believed that plants containing the most nitrogen suffered more severely from blight. The rot is not caused by disease from within the plant, but by external mechanical influences, such as a blow or wound or lightning.

Joel Densmore in October 1867, writing on "The potato disease" urged that more attention be given this disease and gave it as the opinion of many that the decay of the potato was due to inconsistent treatment. Wild potatoes were obtained by the Central Board of Agriculture and these were found to be subject to blight. Densmore advanced the view that the wild potatoes were infected by pollen from neighboring cultivated varieties.

W. Bustin discussed the same disease in March and April of 1868 in the same Journal suggesting electricity as the causative agent, and in July of the same year "A. B." of Halifax gave it as his view that aphids were the cause of the blight.

As early as 1870-71 Wm. Saunders and E. Baynes Reed of London, Ont., were trying out various chemicals for the control of the rapidly spreading potato beetle.

In 1874 Wm. Saunders at the fourth annual meeting of the Ontario Entomological Society drew attention to "Apple-tree blight", which from his description was the now well-known "Fireblight". The attention of growers had already been drawn to "Pear blight" as witness remarks by Saunders, Cross and others in 1872 (see p. 262-264 Ann. Rept. on Agric. and Arts for Ontario) and incidentally it may be noted that Black Knot was discussed on pp. 264-5 of the same report.

In 1875 John McAinish in a prize essay on the pear devoted a paragraph to "blight" mentioning conditions which apparently rendered the trees less suscepible (p. 28 Ann. Rept. on Agric. and Arts for Ontario. Saunders again drew attention to apple tre blight (p. 358 do.) noting the similarity i odour of affected twigs of apple and pear Reference is also made on p. 361 of the sam report to Saunders' plant-breeding work, an of interest at the moment is the statement "Mr. Saunders has also some very promin ent gooseberries, which will equal in siz some of those in Britain, whilst it is though they will be proof against mildew."

Some plant pathology was incidentall taught at the Ontario School of Agricultur for we find in the 2nd Ann. Report (1876 a second year examination paper on Physio logical Botany set by President Johnston con taining the following:

"Question 11—Give the causes of disease in plants, enumerating the commoner diseases

Question 12—Give the pathology of smut rust, mildew and dry rot."

That common opinion still adhered to a considerable extent to the tenets of a previous era is indicated in the presidential address o Robert Burnet in 1877 before the Fruit Grow ers' Association in which he stated that "Fun gus may be a philosophical word, and mer may use it philosophically enough, but to me it would seem when the vital organisms of the apple and pear are injured by the cold that the matter of which the branches are composed assumes the shapes, developes other organisms, which, for want of better terms we call a fungus."

Reading the Seventh Annual Report of the Ontario Agricultural College, p. 5, one finds that Dr. Mills had charge of English, Political Economy, Structural and Physiological Botany and Zoology, and Prof. J. Hoyes Panton, Chemistry Geology, Physical Geography and Meteorology, Systematic and Economic Botany and Entomology.

Between 1883 and 1887 Cline of Winona and McMichael of Waterford experimented with insecticides and fungicides in orchard pest control.

One can understand the difficulties and discouragements of those days, the desire for knowledge, yet the limitations imposed by pioneering in a field even now still young.

Initiation of Definite Work.

In Europe Millardet's Bordeaux mixture was making history and the results of the work of DeBary, Kuhn, Pasteur, von Liebig and others were beginning to be evident. On this side the section of Mycology of the Botanical Division of the United States Dept. of Agric. was incepted on July 1st, 1885, with Lamson Scribner at its head as Mycologist. In 1886 Erwin F. Smith was called to be his assistant and in 1887 it was changed to the Section of Vegetable Pathology. In Canada we find that James Fletcher was appointed Dominion Entomologist in 1884 and combined that position with accountant in the library of Parliament. In 1886 the Central Experimental Farm was established with Prof. Wm. Saunders in charge. He came from London, Ont. and as we have seen by even such few references as have been made he was a leader in Entomology and Plant Breeding and was familiar with then known Plant Pathology. Dr. James Fletcher was then appointed Entomologist and Botanist to the Central Experimental Farm, in which position he continued to divide his time between Entomology and Economic Botany, until his death in 1908. It is interesting to note that in his report for 1887 on p. 9, he acknowledges the receipt of rare specimens for the herbarium from Mr. J. Dearness of London, Ont. You will gather therefore that our guest at this Annual meeting was already engaged in mycological studies when most of us were very young.

In Sept. 1884 George Lawson discussed in the Nova Scotian Journal of Agriculture "The potato disease" in which he gives a description of *Peronospora infestans*. In the same year Professor D. P. Penhallow of McGill University was called to a conference on Fireblight in Massachusetts, when he expressed the opinion that it was a constitutional disease and ventured the view that by the toning up of the trees by the correct use of fertilizers, the disease was preventable. This was the final year of Burrill's work on the bacterial etiology of Fireblight and the second year of Wakker's work on hyacinth yellows. In 1887 Penhallow also published on "The spot disease of Fameuse" caused by "*Fusicladium dendriticum*."

About this time Professor J. Hoyes Panton became Professor of Natural History and Geology at the Ontario Agricultural College and in 1886 he published the first of a series of a dozen reports and bulletins on plant diseases and their control. It is not to be wondered at that his first should be on Late Blight of Potato. Shortly after (1888) Dr. Fletcher issued Bull. 3 of the C.E.F. on "Smuts affecting wheat" followed by a series of reports dealing in part with plant diseases and their control between the years 1889-1906. Between 1890-1897 John Craig, then Dominion Horticulturist, published some twenty-five notes on fruit diseases and their control, while Dr. F. T. Shutt contributed by working on smut in wheat, and on insecticides and fungicides, during the period of 1890-1905. William Blair between 1892 and 1900 studied especially the cause of Bordeaux in controlling Potato rot and the Director, Wm. Saunders, reported on smut prevention in wheat, oats and barley during 1893-1900.

Reference has already been made to incidental instruction in plant diseases by President Johnston of the O.A.C., and undoubtedly such instruction was given every year.

In 1893 Prof. Panton reported that he gave ten lectures in botany covering partly a study of injurious plants such as cause mildew, blight, rust, smut and "spot" on the apple, and certain afternoon periods were devoted to microscopic work in smut, rust, plum-knot and mildew during a Summer School for Teachers at O.A.C. It is safe to assume therefore that more definite teaching was being given by this time in the regular course, and in fact Principal Harrison of Macdonald College recalls that he spent part of his time in 1893 preparing material for Prof. Panton for the work in Cryptogamic Botany and Plant Diseases.

It must be recalled that courses in Mycology and Plant Pathology were of recent innovation in the larger universities of the United States under such men as Burrill, Farlow, Arthur, Halsted and Earle.

Apparently in 1895 the Bacteriologist taught the Plant Pathology for one finds a report by Harrison (p. 189) in which occurs the statement, "In order to place plant pathology on an equal footing it will be necessary to purchase a herbarium of cryptogamic plants....." and in 1896 "The

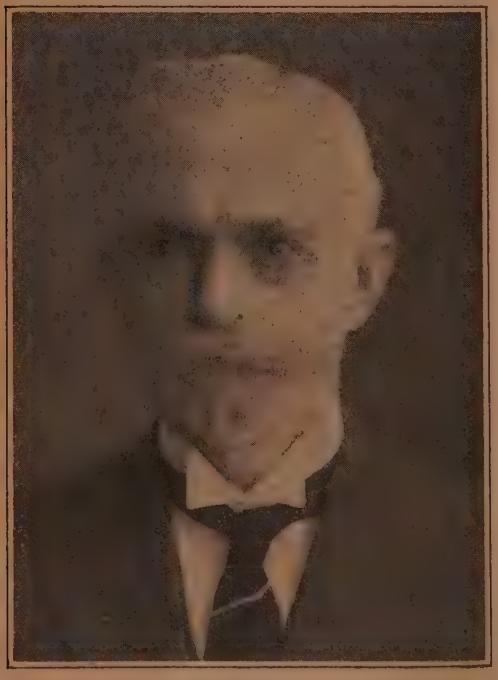
specialists in Biology covered a large portion of the subjects of vegetable pathology and cryptogamic botany". (Harrison, Report of Bact.)

Now for the first time we enter the field of legal enactments for in 1897 "The Yellows and Black Knot Act" and "An Act for the further protection of bees" were passed by the Ontario legislature. By the former it was required of every occupant of land, (1) To cut out and burn all black knot found on plum or cherry trees on his land.....and (2) To cut down and burn any peach, nectarine or other trees on his land infected with the disease known as yellows, and to destroy all the fruit of trees so infected."

The latter prohibited the use of Paris Green or any other poisonous substance injurious to bees in sprays used on fruit trees during blossom time.

A spraying officer was appointed by the Ontario Government to supervise and encourage spraying and a special report was issued by him in 1898.

In 1899 a Fumigation Act was passed in view of the prevalence of San Jose Scale and in 1900 an "Act respecting the Barberry Shrub" prohibiting its being hereafter plan ed and compelling its removal where alread planted, and Prof. Lochhead recalls some i teresting experiences in trying to enforce th act.



Dr. John Dearness

Meantime Prof. Panton died in 1898 an was succeeded by Prof. Wm. Lochhead wh with Manning Doherty, took over the wo in Entomology and Plant Pathology. A this time the three years degree course wa increased to a four year course and Plan Pathology with Plant Physiology definite became courses on the curriculum.

During a period then of approximately te years the seed of knowledge was assiduousl sown under conditions perhaps unsuitable a times, but nevertheless it is to these years th we owe the possibility of our present statu We have but to recall the names of son contemporaneous workers to realize that was a period foreshadowing a great develop ment in the science of plant pathology—Ma shall Ward, Klebahn, Brefeld, Eriksson, etc in Europe and Erwin F. Smith, Arthur, Fa low, Thaxter, etc. in the United States. Ca adian workers then, as now in many cases carried on their plant disease studies at th same time that they carried heavy teachin loads, nevertheless Lochhead published son fifteen papers and bulletins, Manning Dol erty four and McCready three, dealing wit diseases of fruit or vegetable crops caused b fungi. Meantime Harrison was working o bacterial diseases and he published on caul flower rot in 1902, decomposition of roo 1903 and potato rot in 1904. At Ottaw Dr. Fletcher continued his double duty an I think it must be extremely difficult to eva uate the thorough-going yet quiet ground work done throughout the country by tha able lecturer, work which rendered the nex development possible in the federal field Macoun in Horticulture through his Annua reports published notes on many fruit an vegetable diseases and their control betwee the years 1899 and 1909. In the east Sear in the reports of the Nova Scotia Fruit Grow ers Association wrote on spraying and on col lar rots of apple trees.

May I turn your attenton for a moment t the Ontario Entomological Society for w shall find there a case of similar develop ment. This Society was organized in 186

d in 1890 botanical and microscopical sec-
ons were established. In both of these Dr.
earness played an important part giving
ctures on histology, microtechnique and
ycology. In the report for 1892, for ex-
nple, we read "70 species of fungi were
lded to the North American list" and in
e following year "several new fungi have
en added to the list and their life history
orked out." It is of interest to recall that
r. MacClement was Secretary of the Botani-
l Section and took part in the work of both
d that Lochhead succeeded MacClement.

Beginning of Present Status.

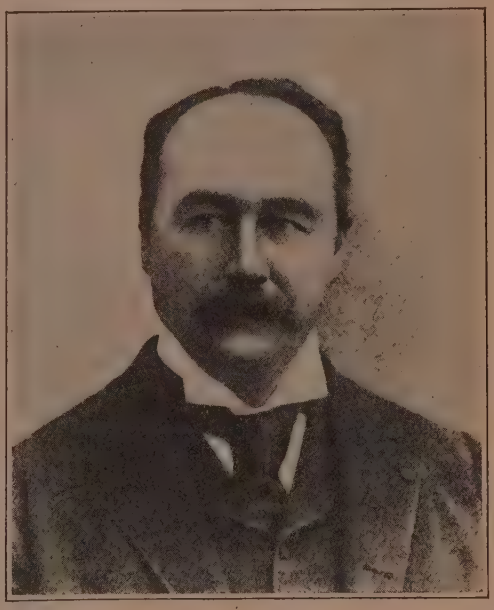
We cannot yet count back twenty years
the time of the actual establishment of our
esent plant pathology, but sufficient has
en accomplished to justify a modicum of
ride in the achievement provided that with
ch pride we realize our greater responsibili-
es of the future. From the educational view-
oint the building and equipping of agri-
ltural colleges was the vital step and in
ch of these Plant Pathology is now taught
a separate course or department. It will
remembered that 1907 saw the first chair
d department of Plant Pathology in an
merican College viz. Cornell. In Canada
e have as yet only one Professor of Plant
athology, Dr. Bisby in the University of
anitoba. During this period Dr. Buller
ommenced his unique studies in mycology
the University of Manitoba and Dr. Faull
eveloped mycology and forest pathology at
oronto, while Dr. MacClement at Queen's
as interested in fleshy fungi and mycology
enerally. At the O.A.C. Prof. Howitt fills
e chair of botany and, ably seconded by
r. Stone, has maintained the prestige of that
stitution in plant pathology. Between them
ey have published well over twenty-five
lletins and scientific papers in addition to
oing extensive work and teaching. Caesar
so has faithfully spread the gospel of plant
sease control by spraying etc. in the fruit
strict of Ontario, while Jones has continu-
l work on bacterial plant diseases. Loch-
ead transferred from Guelph to Macdonald
the foundation of that college and there
w to the placing of requisite courses in
e Dept. of Biology. With him were as-
ociated Dr. Swaine, whose work on the
pruce Budworm we all know, Prof. Fraser,
than whom is no greater authority on rusts in Canada and but one or two in the United States, and the present speaker.

In 1920 the Biology Department was divided and the Dept. of Botany, with Plant Pathology as its chief feature was established with myself at the head. My colleague at McGill Prof. Lloyd, known to you all as a physiologist is keenly interested in what may be termed cellular pathology since it involves studies of individual cells in health and abnormality.

In the Faculty of Agriculture at Manitoba, Prof. V. W. Jackson, orginally with Lochhead at Guelph, occupies the chair of Botany and formerly was responsible for plant pathology as well as other botanical work.

In British Columbia, Prof. Frank Dickson has taken over the work in the University, until 1923 performed by J. W. Eastham the Provincial Pathologist.

Federally the establishment of the Division of Botany as an entity in 1909 was the outstanding event and Mr. Gussow the present Dominion Botanist, was called to fill the position. The large staff of one junior assistant in 1909-1910 compared with the present staff of thirty-one indicates the change which has occurred in federal botanical work. In 1910 the Dominion Government passed



DR. JAMES FLETCHER

"The Destructive Insect and Pest Act" over two years before the Government of the U. S.A. passed the "Plant Quarantine Act."

As a result of the guarantee required on potatoes exported from Canada into the United States, after the embargo had been lifted, it became necessary to institute careful inspection of potatoes for export purposes and thus in 1914 began the inspection service leading to our present "Seed Potato Certification" scheme, which in 1923 called for the employment of thirty-three inspectors. Meantime the service of the Division was extended by the establishment of stations at St. Catherines in 1912, (G. H. Berkeley now in charge) and at Fredericton (McLeod) and Charlottetown in 1915. Extension to the West occurred in 1917 on the opening of laboratories at Brandon (I. L. Conners) and Indian Head (P.M. Simmonds). This was followed by the equipping of centres at Saskatoon (Prof. W. P. Fraser) in 1919, Summerland (H. R. McLarty) in 1921 and Winnipeg (Dr. D. L. Bailey) in 1923. Coming east again a station was opened at Ste. Anne de la Pocatière (H. Racicot) in 1923 and this year saw the establishment of one at Kentville with J. F. Hockey in charge. Tobacco is regarded as a special crop and T. G. Major is in charge of tobacco disease investigations in the Tobacco Division.

The war naturally has had an effect on Plant Pathology in this country as in the United States and one might enlarge on the results of the production cry in drawing attention to the importance of plant diseases and so on, but I will only refer to three points. The founding of the Crop Protection Institute has created a means whereby plant pathologists on both sides of the line may, and do, co-operate in attempting to solve some of our common major problems. It is to be hoped that still more of our problems will be tackled in the future under this scheme.

In 1909 the American Phytopathological Society was founded and two years later Phytopathology appeared. Our scattered members formed a thin lesionary line marking the northern boundary of the society. This persisted until the War Emergency Board of American Plant Pathologists invaded Canada and at that time was discussed in Prof. Howitt's house the formation of a Canadi Branch of the parent Society. Eventually th became *un fait accompli*, in 1919, with Pr J. E. Howitt first President followed in su cessive years by Dr. A. H. R. Buller, Dr. J. Faull, Prof. W. P. Fraser (* 2 years) a myself. We are now but six years old, y in spite of our youth and our few membe we can still maintain a high standard research and professional honor such as wi in years to come redound to the credit of o Society and Canadian Agriculture. I shou not omit at this juncture mention of o other Society devoted definitely to our scien —and I speak of it here because so far my knowledge goes there is no similar so iety in Canada,—the Quebec Society for t Protection of Plants. This Society, the a nual report of which is now in increasi demand, was founded as a result of t efforts of Prof. Lochhead in 1908. T maintenance of the organization and the pu lication of a well-illustrated annual report due entirely to the far-seeing generosity of t Quebec Provincial Government.

Finally the war made increasingly evide the necessity for more accurate informatio concerning the prevalence and economic importance of our common plant disease Hence eventually there was established b the suggestion of the Canadian Branch Plant Disease Survey, which was subsequentl taken over *in toto* by the Division of Botan and is now admirably run by our colleag F. L. Drayton.

Thus far reference has been made to fe eral plant pathology and to teaching and i vestigation in educational institutions, but word is necessary concerning the provinci work. As stated above Ontario in 1898 ha an officer in charge of spraying and while t day there is no specified office of Provinci Plant Pathologist, yet inasmuch as the O.A.C is provincially maintained, Prof. Howitt an his staff function largely in that respect. very satisfactory proof of this is the fa of the establishment at the Ridgetown Exper mental Farm of a field laboratory of plan pathology. In Manitoba and British Colum bia there are special provincial appointment held respectively by Dr. Bisby and J. W

* Dr. Rankin resigned leaving Fraser as actin president one year.

astham. In Quebec Mr. Omer Caron work-ig with Prof. Georges Maheux, is Botanist—post entailing upon him the official provin-al plant pathology.

In still another respect we find Ontario ading the way for the Provincial Forester, Ir. E. J. Zavitz, arranged for investigation in ntario forests by Dr. Faull in 1918 and nce that time work in forest pathology has een steadily maintained. There is now a ederal service in the Division of Botany un-er A. W. McCallum. One must not omit ie work by the forest pathologist in the orest Products Laboratory under the For-stry Branch and reference has already been ade to the work on spruce injury by Swaine.

It is unnecessary to do more than point out at our colleges must be the academic train-ig centres and that they must provide a ood technical foundation for men desirous f making plant pathology a life work. The ct that in Canadian Plant Pathology today ne finds men from the O.A.C., Toronto, ueen's and Macdonald is satisfactory proof f the interest being taken, but it is only re-ently that training in plant pathology was ot concomitant with attendance at an Ameri-an University. In that statement I am not eprecating going abroad for postgraduate aining, far from it, for I think it eminently esirable that everyone should go at some me during the earlier years of getting into arness and before one gets into a rut. It is atisfactory, however, to think that postgrad-ate training in plant pathology is now ob-inable in Canada.

It is always more or less of a difficulty fi-ancing a postgraduate period of study and esearch so that it affords me special pleasure o speak here of the sympathetic considera-on being given to problems in plant path-logy by the Honorary Advisory Council for cientific and Industrial Research. It is by uch grants of money, even though small in ese days of expensive living, that problems, therwise likely to be shelved, are tackled nd students who might otherwise go no fur-ther are more highly trained and available for service when needed in the future.

Recently a list of the charter members of our branch came to my hand and it was a reminder that we have representatives of Canadian plant pathology in widely scattered parts of the world:—Dr. Leslie Coleman in the Malay Straits, Dr. P. Murphy in the Free State, Mr. W. A. McCubbin in Pennsylvania and Mr. E. F. S. Shepherd in Mauritius, and there are probably others not mentioned here but known to some of you.

It is utterly impossible in a presidential address to convey all the detailed facts that one would wish such as the actual problems under investigation and so on, so that I am now going to leave this rather heterogeneous mass to your personal digestion in the hope that I have aroused your interest sufficiently for you to take such opportunities of delving into old records as may from time to time present themselves.

Coming to the immediate present we are in the position of house-warming guests for the Dominion Botanist and his colleagues on their occupancy of a new building. We congratulate Mr. Güssow on the fulfilment of that part of his desires pertaining to working in more roomy, better equipped, modern laboratories and offices, and we feel that the Director of the Farms, the Deputy Minister of Agriculture and the Hon. Minister have done a worthy thing for plant pathology in Canada in supporting and acquiescing in the plans and expenditures resulting in this ideal home-to-be of work for the good of agriculture.

Still further commendation must be expressed concerning the recommendation to Parliament of a grant for a laboratory to be devoted to research on grain diseases in the Prairie provinces. This has been sadly needed for a long time and its establishment will mark a great forward step.

In conclusion I would like very much to congratulate ourselves on having with us at this Annual Meeting our "Rostrup of Canada" —Dr. John Dearness—a mycologist of super-ordinal rank.

Co-ordination of Agricultural Policy.*

H. S. ARKELL

Dominion Live Stock Commissioner, Ottawa.

We are all interested in the success of Agriculture in Canada. We all recognize that the problems confronting the industry are varied and important. We all concede further the effective and constructive work that has been done by our various organizations and institutions during past years. Do we ever pause to think, however, having regard to what has been undertaken or attempted, whether that which has been actually accomplished is reasonably commensurate with the labour involved or the amount of money expended? In other words, is the business position of the average farmer, with respect to the quality of the product he turns out or the return he makes upon his investment, improved and increased to the extent that it ought to be as a result of the heavy annual appropriations which the country must provide in support of this work? As an answer to this question, the views of an official count for very little. What is the opinion of the people of the country? To those who are endeavouring to keep in touch with the trend of public opinion there can be no doubt as to the answer. It is all too unanimously—No. Taxes bear heavily upon business today. They bear most heavily upon the man on the land who is struggling to make a living for his family and himself. The farming public, therefore, even the general public is in an unusually critical mood. The country is asking for a full return for its money and we must admit, it has a right to get it. I should like to lay before you, therefore, the whole question of agricultural policy because unless we frankly face the situation ourselves, we may find the country itself forcing the issue upon us.

We do well to admit the fact of public criticism, even though we may not entirely agree with the critic. That there is criitcism, very definite criticism, cannot be denied. We have had for one thing, Grattan O'Leary's articles in McLean's Magazine. It is true that it is suggested that Mr. O'Leary had no special reference to Agriculture but every civil servant in Canada f the sting of those accusations and insin tions. No man who believes in his job or h a pride in his work could rest easy under think lightly of such sweeping, because u qualified, charges of inefficiency and wor It is an important fact, moreover, that t general public has a lingering feeling th these charges are more or less largely tr This is borne out in various ways. A corr pondent, complaining of egg regulatio writes to the Minister in criticism of insp tors. He says:

> "We now have Fire Insurance Inspectors, come Tax Inspectors, Compensation Board spectors, Minimum Wage Board Inspecto Scale & Measure Inspectors, Egg Inspecto Factory Inspectors, Electric Wiring Inspecto in fact, we are so thoroughly inspected th business has ceased to be a pleasure and h become a burden instead."

Again, an honourable member rises fr his seat in the House to protest against t expenditure on Experimental Farms. Fr another quarter a liveryman refers to t number of Government men that he driv about the country. Another complains th there is too much paternal legislation a illustrates his meaning by reference to h grading. More important still, perhaps, the attitude of the general taxpayer who is bitter revolt against what he terms Gover ment extravagance, without having taken t time to sift out the work which may be va uable and necessary as against that which not.

And now, what answer are we to make this condition of disaffection? That su exists cannot well be gainsaid. Are we pass it over lightly as of trivial account an make no answer at all? I think that wou be a pity. Furthermore, I think that such a attitude would be grossly unfair to those wh are obliged to bear the cost of Governme activities and not wholly just to those wh are engaged in the work itself. Criticis

* An address at the annual meeting of the Wes ern Canada Live Stock Union, December, 192

ay be the very best thing that can happen to
s if we can find the energy to face the facts
f our position and the courage to meet and
aster what these facts disclose.

I am going to ask you, therefore, to join
e in a brief review of present conditions
ith respect to agricultural work. In the
rst place, I should like to say that I yield
o no one in admiration of the work and
orth of the men engaged in Agricultural Ser-
ice. I am proud of my own staff, very
roud, and I know of the loyalty, effi-
iency and disinterestedness of the men in
ther Branches and Departments. Moreover,
might open the eyes of our critics to learn
hat is actually being undertaken and accom-
lished in their interests. One could but wish
ie opportunity of confronting them with the
acts,—Stock Yards supervision, stocker and
eeder organization, boys' and girls' club
ork, plant breeding development, disease
ontrol, etc., but we are not concerned with
iese at the moment. We are interested rather
o the weaknesses of our system and we shall
o well to face these without fear or favor.

The outstanding fact that must be admitted
t once is that, despite the excellent and prac-
cal work which has been done by our Agri-
ultural Colleges and Experiment Stations, by
nstitute propaganda and even by marketing
rganization and product inspection during
ie past thirty years, this work has fallen just
hort of success, owing to the failure to se-
ure the general application of the principles
nd practice so established on the average
arm of the country. This failure is due, not
ecessarily to any inherent weakness in the
ork itself, but rather to the fact that to com-
lete its objective, it must be supplemented
y an effective field propaganda which car-
ies the gospel straight to the people. To
lustrate what is meant, reference may be
ade to the following facts. Notwithstand-
ng many records of 50 and 60 bushels of
heat per acre, to which wide publicity has
een given, the average yield per acre in the
rairie Provinces ranges around the altogether
nprofitable level of 12 to 15 bushels. While
everal Canadian cows have yielded more
ian 30,000 lbs. of milk in one year, the
verage milk return per cow of all the cows
n the country is not more than from 3,500 to
,000 lbs. per annum. While Canadian bul-
ocks are able to carry off championship
honors at Chicago, Toronto and even at Eng-
lish fairs, a large percentage of the cattle
marketed at our central markets is graded as
of inferior or of common quality, due either
to lack of finish or to scrub breeding. There
are men engaged in every phase of our agri-
cultural business who are making today a
fair return on their investment, inclusive of
labour, as, for instance, in dairying, fruit
farming, seed growing, poultry raising, bacon
hog production. So far as the average farmer
is concerned, however, it must be admitted
that his annual revenue represents a very un-
attractive proposition, while on many farms,
there is serious privation if not actual want.
Nor does the yield per production unit, or the
quality of the product, or the business sense
practised in salesmanship warrant anything
but mediocre returns. Two or three weeks
ago, when the first serious freeze-up occurred,
it was a heart breaking experience to note the
tens of thousands of cattle that were rushed
to market, most of them of inferior quality
or lacking in finish or both, with the conse-
quent demoralization of the market and the
bitter disappointment not only to their own-
ers but to the wives and children back in the
country dependent no doubt upon the returns
from these shipments for a large part of their
winter's food and clothing. How can a man
support a family on two cent cattle and how
can he expect to get a higher price per lb.
under conditions such as these? Many addi-
tional examples could be given but, sum-
marizing our most important agricultural
problem may be said to be embodied in the
task of raising the standard of average pro-
duction to profitable commercial levels, of
ensuring that the quality of the product is
what the market requires and of improving
the system of merchandizing the produce of
our farms in such fashion that the individual
farmer may be assured of a successful living.

I should like to repeat that, in connection
with our agricultural work and policies, both
Federal and Provincial, we have most se-
riously failed in our ability to secure the ap-
plication of established principles and prac-
tice on the average farm of the country. Ad-
mitting this, we are then confronted with a
very grave problem indeed; more grave, per-
haps, than at any other period in our history.
The country is faced with high taxation, the
direct result of the war. Taxes in the end

will largely have to be paid out of the product of the land or from our other natural resources. We cannot expect to pull ourselves out of the hole by our own boot straps. In other words, we must sell our products abroad if we are to place ourselves in the position of being able to pay our debts. Canada is naturally an exporting country, so far as agricultural produce is concerned, and whether we export wheat, fruit, bacon, cheese, eggs or any other farm product, we shall find ourselves obliged to face the keenest possible competition from other exporting countries similarly endeavouring to capture the world's consuming markets. All this, of course, has been said before but it is not yet generally realized how seriously and aggressively these other countries are laying plans to develop an export business. We know something of Denmark and New Zealand, for instance, and of their commercial marketing activity, but we fail to realize that other, new countries are now competing for position and their competition will be felt in practically every line that is of interest to Canada. We need take but one outstanding example, namely Russia. That Russia has been out of the race for the past few years, thus giving us a breathing space, may have lulled us into an indifference to her stupendous, natural resources. Students of world supply are already finding signs of marked development and in grain, bacon and dairy products, she may shortly become a particularly formidable antagonist. In a word, it cannot be doubted that Canada's economic position and opportunity is sound but if we neglect to apply ourselves by way of aggressive, national policy, to the production and marketing of a quality product at reasonable cost and in quantity sufficient to gain permanent and continuous recognition on the export market, we shall find ourselves out of the race. Herein lies our danger, not only from the national point of view but from the point of view of the individual farmer whose comfort and ability to make a living is dependent, in a large measure, upon the success of our export business.

It is fitting then that we should consider well the weaknesses in our present agricultural system, the weaknesses which have permitted the continuance of the problem to which reference has just been made. I think, perhaps, one of the most outstanding faults in this sy tem has been in the focus and direction have given our work. There can be only o legitimate end to which, broadly speakin we must aim, namely that of endeavouring aid the farmer in making a better livin Farming is essentially a business; industrial it is a business; technically it is a busine and unless our work, whether from an educ tional, experimental or promotion point view, is directed toward developing and i proving it as a business, it is missing t mark. Of course, objection will be raised this statement but, broadly speaking, it true and in principle it is sound. Furthe more, and in the same manner, any oth objection is fundamentally and economical wrong. I should like to ask those prese whether engaged in educational, research promotion work, whether their activities those of their allies and associates are defi itely directed to this end. I am afraid must all confess to serious sins of omissio in this respect. Permit me to illustrat Possibly the illustration I have selected m be thought to represent bad taste on my pa but, inasmuch as I have spoken directly those immediately interested, I may be pa doned for referring to the matter again this time. I have in mind the objective a direction of educational policy in our Agr cultural Colleges. I beg leave, therefore, quote from a letter which I addressed President Klinck, as Chairman of the Com mittee on Educational Policy, and which w read by myself, by special request, at th meeting of the C.S.T.A. at Guelph in Jun last. Speaking of the effect of College train ing upon agricultural practices, the quotatio is as follows:—

> "If one is to interpret public feeling at th present time, it would seem that there is t great a divorcement of relationship as betwee the aims, purposes, methods and policies of o colleges on the one hand and the interest problems and practices of our farmers an breeders on the other. In other words the would still seem to exist a gulf which has n yet been satisfactorily bridged as between col lege and farm, which is particularly unfortun ate in that it retards the establishment confidence and hinders the development effective and constructive work.
>
> Is the solution of this issue not to be foun in amending, in any such manner as is pos sible, the direction and purpose of presen educational policy by placing less emphasis up on the academic features of college curricu

and more upon training in connection with the commercial problems of the business of farmers. It is perhaps difficult to fully state one's meaning in a brief letter but until the college vitally concerns itself, in the training it gives its students, with the problem of how to make money out of farming, I do not think that the college is discharging its full responsibility to the farming public. Moreover, I think that by accepting responsibility in this direction, our colleges will give their students greater appreciation of the function and purpose of agricultural education and at the same time will cement a practical and close relationship as between the farmers and themselves."

The justification for writing or talking in this fashion can, perhaps, best be found in what occurred after the presentation of the statement. A strong, forceful discussion developed in support of the views as outlined and the whole question is now under further consideration by the Committee.

One might pursue this argument further, inasmuch as there is a steady undercurrent of public opinion which is beginning to find expression in favour of a reorganization or a readjustment of general agricultural policy, including that with reference to research, education, inspection and propaganda. It is beginning to be realized that the problems which dictated the initiation of policy twenty and thirty years ago are quite different to those confronting us today and it is being similarly realized that we have been all too slow in adjusting pre-war policies to meet present day demands. When the work of our Departments of Agriculture was first initiated, the country needed, above all else, to know what to do. This was the justification for the creation of our first Agricultural Colleges and Research Stations and for the undertaking of work which would make available the facts as regards methods of tillage, varieties which would return maximum yields, feeds which would ensure highest gains, types of animals which were best adapted for particular purposes and measures which would provide satisfactory disease control in plants and animals. The results of policies then undertaken have been an accumulation of facts, the value of which would be inestimable, had they been put to use. Herein lies our present day difficulty. It is to secure the general application of the principles and practices established as a result of thirty years work. We know better than we practise. We are under the necessity, therefore ,of adjusting our general policies to this end and if in the process there are to be considerable heartburnings and the breaking up of accepted notions, there can be no question that the country as a whole and the men concerned in the work will benefit by the change.

This leads us to a statement of the second great weakness which I am convinced is to be found in our existing system. I refer to the competition, duplication and lack of co-ordination that exists not only as between Provincial and Federal Departments of Agriculture, but also as between and within the several organized units into which our various lines of work naturally fall. Such duplication and failure to co-ordinate is quite to be expected during the process of adaptation of policy to modern commercial conditions which is now undoubtedly taking place. Unfortunately, however, it is seriously retarding our work, has already been taken cognizance of by the country and is proving the most fertile source of the criticism already referred to.

Again let me illustrate. Prior to the initiation of the National Bacon Policy, the differences that existed as between Federal propaganda, research objective and educational policy were such as to constitute a serious reproach upon our whole system. The country was rapidly drifting into a chaotic condition, so far as hog production policy was concerned. Undoubtedly, improvement has been effected but with due respect to the differences of opinion that must exist, we have still failed to standardize as between College, Experiment Station and Field work, types, method and policy, I could refer to one particular institution, and the illustration is not an isolated one, with which we have entirely failed to co-ordinate the objectives and standards of our work. Either they or we are wrong, and, without attempting in any way to pre-judge the issue, the fact remains that the country suffers while this condition lasts.

I could refer to another institution with which we have failed to agree as to cattle feeding policy. The difference of view in this case is almost fundamental. We have endeavoured to evolve a policy in line with the economics of cattle feeding. Our neighbour has accepted the dictates of show ring standards and is supported by strong breed organizations. There is, therefore, a distinct

clash as between two bodies of public opinion. Who is to set us right and to co-ordinate our joint efforts in a policy that will best serve the interests of the country?

One could continue at length in this fashion. Reference might be made to the duplication in research and to the difference in method between the policy followed in this country where comparatively little effective connection exists as between organized agriculture on the one side and the elaborate system of research activity carried on by Provincial and Federal Departments on the other, as against the policy followed in many European countries, Scandinavia for instance, where organized agriculture practically determines what and how research shall be undertaken.

Reference might also be made to the natural competition and duplication which exists as between Federal and Provincial policies, in connection with which the human factor or personal equation has a most important bearing upon the measures which can be adopted toward securing effective correlation between different Departments. Elaboration of this argument is, however, unnecessary, except to say that where divided counsels prevail, and, unfortunately, they do prevail, the cost to the country is increased and efficiency is correspondingly reduced. No argument can justify this situation, particularly under present conditions, and there will be general agreement that a determined and comprehensive effort ought to be made to remedy the evil. I have not attempted to probe too deeply into this cancer growing within our administration, because there can be no object in hurting each other's feelings in this analysis of our position. Rather I am asking that the knowledge and understanding of those present may be applied to the question as it has come within their own personal observation. If this be done, there will be sufficient food for thought without further elaboration at the present moment. I want to say, however, that I believe that every honest and earnest student is aware of the facts to which reference has been made and is seriously anxious that these problems should be tackled and, shorn of all political influence or personal prejudice, that remedies be sought which will improve the status of our work and correlate our great Departments of activity into a common policy working effectively and harmoniously in the interests of the farmer and of the State. No other objective is worthy of the energy or the money that is being put into the work at the present time and no other method will secure for Canada the economic and commercial position which is absolutely essential to our future well being.

How can this be done? I think that twelve or fifteen years ago Dr. C. C. James conceived the right idea and was in the way of formulating the only effective plan. In this connection, I am not necessarily speaking of the money consideration involved, although one must admit that there are financial problems embodied in the project to which attention must be paid. At the moment, however, I have reference rather to the vision which Dr. James undoubtedly had of the establishment, first of an entente cordiale between the men engaged in the various Departments of Agricultural Service, and, secondly, of a steadily growing alliance and correlation of activity in the carrying out of their work. Some of us thought at the time that his ideas were not wholly sound. Some of us still think that there were weaknesses in his system but many have learned to admit that the conception of his idea was fundamentally in the right direction. We have learned, too, to pay belated tribute to the service and work of the man himself. We need in Canada a great coordinating medium that will act, not only as the liason office correlating and coordinating the work of our different Departments and Institutions but, as well, assisting these to function, in proper relationship, the one with the other, in the development of comprehensive national policies as having to do with our several lines of agricultural industry and trade. How can our bacon business, our butter and cheese business, our fruit business, our egg and poultry business, our cattle and beef business, prosper, unless a common objective, common standards, common policies, formulate the curricula of our Agricultural Colleges, determine the teaching methods and ideals of their teachers, inspire the workers in agricultural research and command the activities of our field agents whose duties bring them in direct contact with the people of the land? We have a common enemy in

the inefficiency in farm management and in the merchandizing of farm produce. We have a common problem in securing the application of recognized principles and practices in all phases of our business. We cannot afford, therefore, to have other than a common policy to which each unit, jointly and cooperatively, contributes in working toward this end. Nothing less will reduce cost of administration to the minimum, promote real efficiency in all Departments of our work and bring to bear the full potential opportunities of our joint efforts in enabling the individual farmer to make a comfortable living and the country as a whole to develop a trade policy commensurate with her resources and the energies of her people.

I do not mean to suggest the creation of another Administrative body, a sort of Super-Department. That would be adding evil to evil. Let us rather find a carpenter, a plain man, but with something of the genius of a builder in his make up, having had a vision of the structure to be erected, and the use to which it is to be put; withal, fortified by the courage of his convictions and having the patience and tact to complete the scheme he would create. Set him to work first with pencil and paper so that he may fashion his design. Give him, then, saw and chisel that he may set in order his material, and if this proved obstinate or hard to fashion, and he require a mallet or hammer, refuse him not what he needs.

His task may not be as difficult as might at first appear. He will at least find plenty of timber available, probably all the men he requires, possibly even sufficient money. His greatest task will be in dovetailing policy to fit policy, in joining measure to measure, in shaping and building all into the scheme of things already set down and in discarding surplus or obsolete material. One thing he may lack—authority. This can come only by common consent. Much progress may be made by tact, argument and conference, the rest must be achieved by public opinion. With this at his back he has little to fear. If he hasn't got it, let him create it, even if it takes years, or change his plan. Given conviction, courage, patience, couple these with the power of public opinion and the issue is assured.

That one speaks in metaphor ought not to weaken the force of his appeal. We have already delayed too long in tackling a job which may prove our undoing if we do not master it. A "Laissez Faire" Policy, a "let things drift" attitude, trusting to time to correct them, may seem sound to a philosopher, but it can never command the respect, confidence or judgment of a young and growing country. It has never been thus that Great Britain, in the making of the Empire, has acted in times of emergency, even the last one. It was not thus that civilization was saved from German aggression. It was not thus that the Fathers of Confederation shaped the destiny of Canada, politically and industrially, for all time to come. It is not thus that we shall settle the problem of Agriculture, no whit less important to the future welfare of our own people. What we need is positive, decisive, resolute action, concentrating our energies and directing our efforts, jointly and severally, towards securing the general application of recognized business principles of production, management and marketing on the individual farms of the country. Therefore, may we give expression to our faith as to the opportunities that are offered us, may we justify the service that we owe to those for whom we have elected or have been elected to speak, by accepting responsibility for our position in the words of the ancient sage—"To see our duty is to do it."

Economy of Standard Type in Fowl.*

Why It Should be Preserved.

W. A. MAW

Macdonald College, P.Q.

What were the original aims in mind when our Standards were made? Certain types were developed for egg production solely, other types for meat production, and still other types for a combination of the former aims—eggs an dmeat. What has been the result of some of our past procedure in the selection of breeding stock, especially for high egg production? In some cases, a complete loss of standard type for the breeds represented; in some a loss of size and body; in some a loss of size of eggs laid, while in others a great loss in vigour. The last factor mentioned, that of loss of vigour, has been most pronounced in cases where close in-breeding and line-breeding have been followed with too great emphasis of pedigree alone with a sacrifice of body size and vigour in individuals. Is it not time that we change some of our ideas in relation to the selection of breeding individuals and make less haste in obtaining our end of high production and ensure a combination of such factors as standard type and colour, as far as possible, with size of body, size of egg and vigour with high production? Will it not be to our advantage in the end? Would it not be more economical production? Just think of the effect of the loss of such factors as size of body and vigour on production in general! Why do certain flocks of birds suffer greater loss when attacked by disease? Is the lack of vigour in our stock not a big factor there? Naturally, general management plays a big part but the lack of vigour means predisposition to certain diseases.

At present we are noting considerable comment on "Production-bred stock" lacking in standard characteristics, especially that of type and colour. The question in the past has been as to whether it was possible to combine the two qualities of standard type and production type in the same individuals. A great many breeders neglected to consider standard requirements when making up their breeding pens and the resulting progeny from year to year following have gradually lost all standard qualities as type and colour and to-day they are faced with the problem of getting back again to somewhere near the standard requirements. They may have attained high average productions in their flocks and now it is a case of how best to introduce the quality lacking in their stock and at the same time preserve the production standard attained.

General Impressions in Past

In the past those poultrymen who were attempting to develop bred-to-lay strains of poultry developed certain impressions regarding the value of certain characteristics as noted in their stock through constant close observavtion—especially where the stock was being handled under trap-nests to obtain definite individual egg records and records of such factors as broodiness, length of laying cycle, persistency in laying or time and duration of molt. Other factors were also noted in the growing stock which tended to give the poultryman certain ideas which have since been carried in mind and used quite extensively in the selection of stock for future breeding work. Some of these ideas of the value of certain of these characteristics or factors have been very valuable while others have been detrimental to the future of the work in developing better stock.

Size of Bird

One of these above intended factors has been size of bird. Through continuous handling of bred-to-lay females under trap-nest work it has been noted that the medium sized females, rather than the small or oversized females, have been as a rule the heaviest layers. Continuous selection along this line of under-standard-sized females has tended to lower the average size of our flock individuals, not only females but males as well. What is the economic significance of such a practise? Is it not detrimental to economic poultry production? Will it not mean in the

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end that the stock will be too much under standard in size to be looked upon as being a true representative of the breed represented? What about the meat value of female and male stock when being offered on the market? Has this point not already been hinted at in the press? Has it not already been noted by the bred-to-lay breeders that the surplus males do not make as good roasting stock when fattened? They lack substance in body. This is a very worthy point to keep in mind if we are to continue to produce representative stock of our various breeds.

Body Size and Egg Production

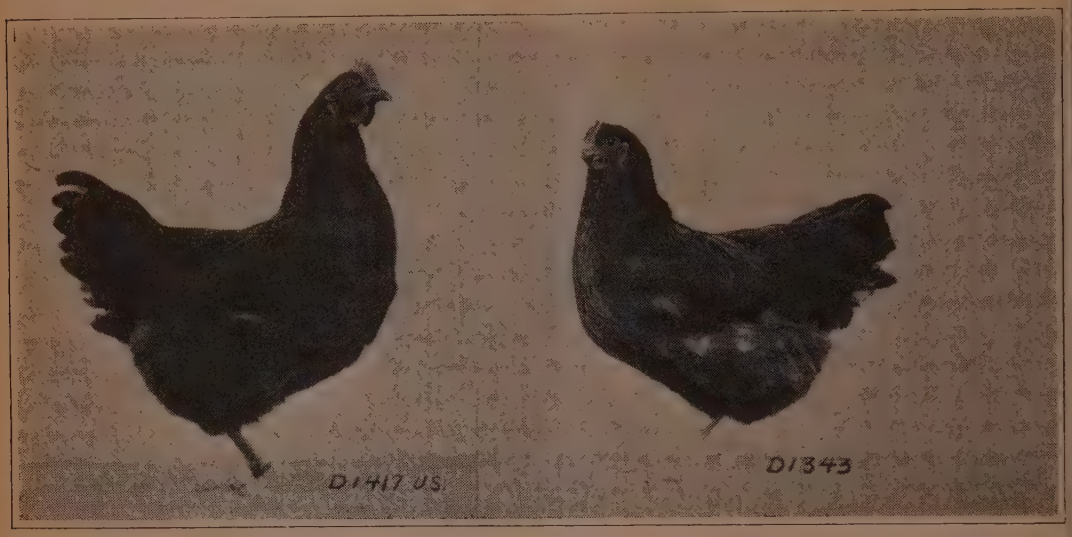
Has body size in the individual anything to do with maximum egg production? Yes! If we are to expect maximum egg production from a female throughout the year, and especially during the fall and winter months we must develop good sized bodies that are well fleshed before we force them into heavy production. Without full body weight and the maintenance of same, we cannot expect to maintain persistent laying during the twelve month production year.

Rate of Body and Sexual Maturity

Two other closely allied factors come into play with body size and production which are of extreme importance to the commercial poultryman. We have often heard it said that the early maturing female is generally the heavy yearly producer. Also that the bred-to-lay stock matures sexually and comes into laying at an earlier age than does the strictly exhibition bred stock. What factors influence early sexual and body maturity? First we may say heredity. It is the breeding. The birds having been selected for those factors naturally mature early. Second, it may be a factor in management. Management has a great deal to do with it. Perhaps management is the one means of controlling maturity. The experience of the poultryman will largely determine as to whether he will gain or lose by getting early maturity. Why? One point is to get early sexual maturity and profit by it by high egg production. The other point is to get early sexual maturity without body maturity and lose thereby because the birds will not be able to withstand the strain of heavy production due to lack of surplus body flesh and fat. The secret is to get early maturity sexually and bodily combined at the right time to bring the pullets into profitable fall production and have them in condition to continue to lay heavily during the winter and spring months. The method of feeding the pullet stock during the summer and early fall months will largely determine when the pullets will reach the stage of maturity and how they will be able to withstand the laying strain after commencing to lay.

Figures 1 and 2 represent Single Comb Rhode Island Red Pullets. D1407 is a precocious female coming into laying at an early age weighing five and one half pounds. Her sire's dam laid 235 eggs as a pullet and 14 females in her pedigree laid an average of 210.2 eggs as pullets.

D1334 represents ideal Red type and carries exceptionally sound red colour throughout her body. Her dam laid 162 eggs as a pullet and 12 females in her pedigree averaged 175.3 eggs as pullets.



Figures 3 and 4 represent the small or medium sized Red pullets. D1417 is the early maturing precocious layer and the kind that generally lay a great many small eggs. She is too small to be used as a strong breeder. D1343 is the weak type of pullet that should be discarded rather than fed as one cannot expect her to be a profitable layer or breeder.

General Quality in Individual Make-Up

Another general impression has been that the standard-bred stock lack the type in body make-up that lends to high egg production. That impression is wrong. The general make-up of the individuals in the flock is largely determined by the method of selection carried on by the breeder. There is no reason why the proper combination of standard sized females with fair type and colour with high egg production cannot be built up by careful selection in any of our breeds. We are gradually seeing individuals of exceptional merit in standard breed characteristics coming forward with phenomenal official yearly egg productions. Undoubtedly these individuals are exceptions to the general rule at present but the time will come when we shall see the happy medium developed. All present day breeders who intend to progress continually in their breeding work must look to this end to strive to develop the combination that will make the "Useful more beautiful and the Beautiful more useful".

The Individual Layer

What do we want in the individual female as regards type and quality to be a prospective heavy layer? Is it not the wedge-shaped capacious body with fineness of bone and skin, with a clean cut appearance about the head and a full prominent bright eye and last but not least strong constitutional vigour? Are these impossible characteristics in a standard typed female with good colour? They should not be. Do our present day breed standards not lend to such selections?

Size of Egg

Has body type and size anything to do with the size of egg laid by the individual female? Do we not find that small sized females have a tendency to lay small eggs in their pullet year at least? Why do people often ask why it is that certain flocks that have been bred for high egg production lack in size of egg? This factor of size of egg must be kept in mind continuously when breeders are being selected or the result will be that owing to pedigree and production data alone being used a strain of small egg layers will be developed. Of what economic value is size of egg? The standard sized egg should weigh at least two ounces. The two ounce egg is generally hard to get from the average bred-to-lay pullet when commencing to lay her pullet year production unless she has been especially bred for that factor. The under-standard-size pullet as a rule lays too many under-sized eggs before attaining the full two ounce egg size. Such production of small eggs is not economically sound. The cost of egg production is practically the same

for small and large sized eggs but the selling value is less for the small eggs.

The hatching power or reproduction value of the undersized eggs is also less. Small eggs produce small chicks and the small chicks develop into small individual birds who in turn lay small eggs due to heredity.

General Method of Selection for Improvement

How can we best correct any defects regarding type, colour, production or size of egg in our flocks with the least amount of danger of destroying what we have already built up? Where definite lines of breeding have been established it is generally wisest to attempt to correct any defects within the line, (wherever possible) rather than by the introduction of new blood. In some cases it is necessary to bring in new blood for improvement work in order to save time. In such instances we must introduce the new blood to only a part of the general flock to test it out as regards its quality in combining with the present line of blood. The first generation may show a decided improvement in some of the progeny but the second generation will give more accurate information as regards its effect on the egg production of the stock.

The most logical plan of procedure is to follow at all times a sane plane of selection for the various factors wanted in the flock, gradually changing over and correcting certain defects as progress in egg production is being made.

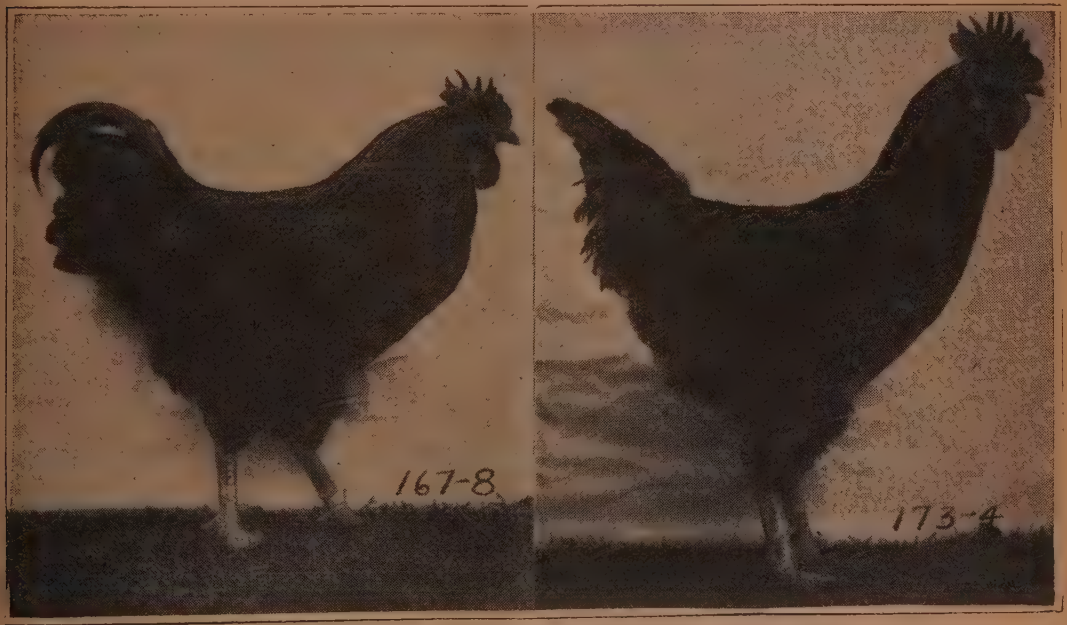
The Outstanding Factors in Selection:

1. Constitutional vigour.
2. Pedigree.
3. Standard Breed type and colour.
4. Production of eggs—(yearly, winter cycle, length of laying cycle, persistency in production).
5. Early sexual maturity with standard body size and weight.
6. Size of egg.

Most of these factors have been stressed in the foregoing paragraphs but such factors as constitutional vigour, pedigree, and production performance might be further emphasized.

Constitutional Vigour

The factor of vigour in the stock is of most extreme importance if the stock is to be expected to withstand close selection along



Figures 5 and 6 represent Single Comb Red cockerels from two separate lines of breeding. 167-8 has been bred for a combination of Standard Red type and colour with high egg production. His colour is exceptionally good throughout. His dam laid 261 eggs as a pullet and 8 females in his pedigree laid an average of 190.38 eggs as pullets.

173-4 represents the type where egg production records, size of egg factor, and vigour have been stressed. A most vigorous type but slightly coarse in make-up and light in colour. His dam laid 235 eggs and sire's dam 265 eggs as pullets. 14 females in his pedigree averaged 210.2 eggs as pullets.

certain blood lines and inbred. Perhaps this factor is lacking too much in many of our closely bred strains of poultry. Only the most vigorous of individuals can withstand heavy forced feeding for production and then go into the breeding work and produce fertile hatchable eggs that will produce vigorous chicks. This factor should be of first consideration if we are to propagate a strain possessing longevity of life and breeding value.

Pedigree

The use of the pedigree of stock in improvement breeding work is now becoming more generally recognized. Without some knowledge of the individual ancestral make-up of our birds along the line of aim in mind we cannot expect to make definite and continual progress. The actual line of blood behind the birds must be known. In breeding for increased egg production the more we know about the productions of the ancestors of our stock the better can we select and mate the stock. The higher the average production behind an individual by taking the average of production in all its ancestral's dams and granddams the better is the bird as a prospective breeder of high producers.

Production Performance

When selecting stock for breeders to produce better producers of eggs we must consider not only the actual number of egg laid by the female in the given year but als when the eggs were laid. Did she lay her pu let year's production by starting in Septemb and laying until June the following year d did she lay until August thirty-first takin twelve full months? Or did she continue t lay more than a twelve month period? C on the other hand was she a late starter an an early quitter? Then how did she la those eggs–in short cycles of two or three an skip a day or did she lay longer cycles o four, six or even ten or more without a ski and then repeat approximately the same cycl thereby laying high monthly records? An then again how many of the eggs were lai during the winter period or the period o high market egg prices? In other words, wa she an economical producer from the stand point of profit per dozen on eggs laid?

After considering the factors as mentione heretofore is it not sane to believe that throug judicious thought and study of our indivi duals in the flock we can and should produc a line of fowl within most any of the breeds or varieties within the breeds, that shoul combine production with fair standard typ and colour? The study and selection of th individual bird is of the greatest importanc and from this end only can we expect t make our progress in future breeding work.

Figure 7 is a bred to lay Rock cockerel that has been bred for high egg production and size of body with fair colour. His dam laid 250 eggs and 23 females in his sire's pedigree averaged as pullets 232.18 eggs.
1011 represents a Single Comb White Leghorn cockerel that has been bred for high egg production and standard type combined. His dam laid 200 eggs and ten females in his pedigree laid as pullets an average of 166.4 eggs.

Une visite aux mines de potasse d'Alsace.

H. M. NAGANT

Institut agricole d'Oka, La Trappe, P.Q.

Situation et Origine.

La vallée du Rhin entre Bâle et Mayence représente une sorte de large fosse ou bande d'effondrement de l'écorce terrestre, située entre les deux massifs surélevés des Vosges à l'Ouest, et de la Forêt-Noire à l'Est. La plaine d'Alsace forme le fond, très plat, de ce fosse.

Tout de monde se souvient assurément aussi du "Vieil Armand", de tragique mémoire, nom si souvent paru en vedette des communiqués de guerre au cours des quatre angoissantes années. C'est l'appellation familière que les poilus ne manquèrent pas de substituer à la dénomination géographique officielle de Hartmannswillerkopf, trop difficile à expectorer pour un gosier français, désignant un sommet désormais fameux en bordure des Vosges.

Aujourd'hui encore, les innombrables abris ruinés, les moignons d'arbres broyés par la mitraille ou calcinés par le feu des explosions, lamentables vestiges de la dense forêt qui garnissait ses pentes, têmoignent assez de la lutte féroce et du terrible carnage qui marquèrent les efforts surhumains déployées pour la possession de cette sinistre montagne.

A son pied succède brusquement, sans aucune transition, au massif montagneux, la plaine d'Alsace, au centre de laquelle on devine le cours du Rhin s'en allant en direction Nord. L'active ville de Mulhouse, bien connue pour son importante industrie textile s'étale à quelques milles de distance.

C'est dans cette partie de la plaine qui sépare Mulhouse du pied du vieil Armand, qu'un ingénieur, du nom de Fernand Vogt, entreprenait, il y a une vingtaine d'années, une série de sondages dans le but de découvrir des sources de pétrole. Mais, au lieu de trouver le liquide qui pèse plus dans les conférences diplomatiques des grandes puissances que n'importe quelle consideration de sentiment ou de justice, il tomba, à une profondeur de 625 mètres (2065 pieds), sur une couche d'un sel bigarré, épaisse de 5 pieds en moyenne. Un peu plus bas, soit au niveau de 650 mètres environ (2150 pieds), le sondage rencontra une deuxième couche de sel analogue, mais d'une puissance variant entre 8 et 15 pieds.

Une source de richesse autrement formidable que la plupart des mines d'or qui possèdent le don d'exciter si facilement l'imagination du public naif, venait d'être révélée au monde.

Importance du gisement.

En effet, l'examen des échantillons du sel bigarré indiqua qu'on se trouvait en présence d'un minéral composé essentiellement d'une association de chlorure de potassium et de chlorure de sodium ou sel de cuisine ordinaire, connu sous le nom de "sylvinite". Les analyses faites depuis apprirent aussi que la teneur en potasse pure de cette sylvinite était de 22 à 25% dans la couche supérieure, tandis qu'elle varie entre 15 et 20% dans la couche inférieure, plus épaisse. D'autre part, l'étendue du gisement actuellement délimité à la suite d'un grand nombre de forages, atteint une superficie d'environ 50,000 âcres. De ces données, on a déja pu conclure, par un calcul fort simple, qu'il renferme une quantité de sel brut d'approximativement deux milliards de tonnes, correspondant à au moins 300 millions de tonnes de potasse pure, ce qui, exprimée en argent, représente un nombre respectable de milliards de dollars en puissance. Aussi, après tant d'amères déceptions au sujet des réparations, nous pouvons au moins nour réjouir en songeant que la France trouve dans les riches gisements de potasse qui lui reviennent par la rétrocession des provinces perdues un facteur de compensation réel pour le ravage de la plus belle partie de son territoire par les hordes allemandes.

Origine géologique.

Le mode exact de la formation des dépôts de sylvinite d'Alsace est encore assez mystérieux, parait-il, et laisse le champ libre à bien des hypothèses. Suivant Monsieur Jacques de

Entrée d'une galerie de mine de potasse en Alsace.

Lapparent, professeur à l'Université de Strasbourg, l'allure particulière des couches semble étayer l'idée que l'origine en est due à l'évaporation des eaux d'un lac périodiquement enrichies en chlorure par l'afflux de cours d'eau qui lessivaient des gisements salins anciens.

Quoiqu'il en soit, nous savons que les gisements de sels potassiques de la région de Mulhouse remontent à l'époque géologique dite "Oliogocène" ou fin de l'ère tertiaire, et sont par conséquent de formation beaucoup plus récente que les dépôts allemends de Stassfurt qui datent du Pérmien ou fin de l'ère primaire.

Exploitation sous le régime allemand.

Découvert en 1904, ce ne fut qu'après plusieurs années d'explorations et de sondages complémentaires qu'on commença à y établir, en 1910, des sièges d'extraction. En 1914, à la veille de la guerre, quatre groupes de compagnies minières, dont trois allemands et un français, se partageaient l'exploitation du bassin minier. Mais l'exploitation n'en fut pas poussée avec une bien grande ardeur, et cela se comprend, car le Kalisyndikat allemand, dont les entreprises nouvelles furent obligées de subir le contrôle, tenait avant tou à ménager les intérêts des nombreuses min anciennes qu'il groupait dans les vieilles classiques régions de sels potassiques du ce tre de l'Allemagne et du Hanovre.

Survint la guerre avec sa période de boul versement industriel qui fut fatal au dévelo pement des mines de potasse. Par suite d manque complet d'entretien et de d'arrêt d l'épuisement de l'eau, plusieurs puits furen noyés.

Reprise des mines par le gouvernemen français.

Lorsque l'administration française prit po session des mines, à la suite de l'entrée trion phale de ses armées victorieuses en Alsac un grand travail de remise en état et de r organisation s'imposait. Outre le problèm de vaincre la crise des transports et la di ficulté de ravitaillement en charbon, il falli remplacer le personnel technique et pourvo à l'embauchage de la main d'œuvre dispersé

C'est dans les termes suivants qu'un bulleti publié récemment par la "Société Com merciale des potasses d'Alsace", rend compt de l'œuvre accomplie depuis l'armisti

jusqu'en l'année 1921: "Grâce à son dévouement et son activité, le personnel, a su, par un labeur opiniâtre, tirer tout le parti possible de notre nouvelle richesse nationale. On peut escompter un avenir plein de promesses. L'ensemble du bassin parait capable, avec les travaux prévus, de donner dans les prochaines années 14,000 tonnes de sels bruts par jour ouvrable, soit en chiffres ronds 4 millions de tonnes de sels bruts par année."

Aussi ce fut une éxploitation en pleine activité, conduite entièrement par un personnel technique français, que nous eûmes le plaisir de rencontrer au mois d'aout dernier, lors d'une visite à la mine Amélie, située à une couple de lieues de la ville de Mulhouse.

Descente dans la mine.

Sous l'obligeante conduite de monsieur Lefèvre, ingénieur agronome remplaçant, en l'occurence, monsieur Louis Hautmont, directeur général du Bureau d'Etudes sur les engrais annexé à la Société Commerciale des potasses d'Alsace, et pilotés par un ingénieur des travaux du fond, nous prenons place, avec un certain nombre de wagonnets chargés de matériaux destinés au remblayage des galeries, dans le grand ascenseur prêt à s'engouffrer dans un puits de 18 pieds de diamètre. A un signal donné, la cage d'acier commence à se dérober sous nos pieds, comme la trappe sous un condamné à la potence, et nous la suivons dans sa chûte assez rapide, pendant que suinte le long de ses parois une lessive visqueuse de sels de soude et de potasse, provenant de légères infiltrations d'eau qui arrivent à pénétrer à travers le cuvelage, d'une construction aussi étanche que possible, cependant, dans sa traversée des terrains aquifères et des sables boulants. Sans nous arrêter à la première couche de sels potassiques, nous sommes rendus en peu d'instants à l'étage inférieur qui nous rapproche de plus de deux mille pieds des chaudes entrailles de la terre.

Au terme de notre voyage vertical s'ouvrent de vastes galeries, larges de 15 à 18 pieds, creusées dans toute l'épaisseur de la couche de sylvinite dont la puissance atteint ici une dizaine de pieds. On aperçoit le plafond, formé de schistes recouvrant directement le dépôt salin, étançonné par un vigoureux boisage qui ne semble cependant pas bien nécessaire ici, vu que le terrain, étonnamment solide, n'a pas l'air de travailler sous l'effort de l'évidage comme c'est ordinairement le cas dans les mines de houille où les galeries s'écrasent continuellement en pliant et brisant les bois de soutènement. La lumière projetée sur les parois latérales se réfléchit en mille teintes chatoyantes sur les couches alternatives de sels diversement colorés dont est constitué le dépôt de sylvinite.

La sylvinite.

Le précieux minéral extrait à 2000 pieds sous terre est constitué essentiellement, ainsi qu'on l'a dit plus haut, d'une association de chlorure de sodium (ou sel gemme) et de chlorure de potassium (ou sylvine) avec accessoirement de petites quantités d'autres sels que nous omettrons de nommer. Dans le gisement de Mulhouse, le sel gemme et la sylvine forment un grand nombre de petites couches superposées, séparées le plus souvent par de très minces lits argileux.

Voici ce ques nous dit monsieur Jacques de Lapparent, déjà cité: "Les petits lits de chlorure dont l'épaisseur varie de 7 à 15 centimètres (2¾ à 6 pouces) sont très uniformément constitués, à la base, par du sel gemme et un peu de sylvine, au sommet par de la sylvine avec un peu de sel gemme. Le mélange riche en sylvine (donc en potasse) est coloré en rouge tandis que la base de la couche est faite de sels blancs ou grisatres. La couleur rouge provient de très minces paillettes de fer oligiste (sesquioxyde de fer) qui imprégent les cristaux de sylvine sur leur pourtour. Ces derniers, sans contours nets, forment un agrégat grenu et la couleur rouge est d'autant plus intense que l'agrégat est plus fin. Les parties les plus riches sont celles dont la teinte est rose claire; la teneur en chlorure de potassium peut y atteindre jusqu' à 98%.

Extraction des sels potassiques.

Guidés par l'ingénieur du fond, on s'engage dans le large tunnel semblable à un corridor de quelque palais de conte de fée. En route, nous croisons tout un convoi de wagonnets tiré par une petite locomotive électrique ou à benzine, je ne m'en souviens plus, qui se dirige vers l'acrochage avec sa charge toute miroitante. La chaleur humide que règne à cette profondeur se manifeste plus intense

à mesure qu'on s'éloigne du puits, pour devenir réellement accablante dans les endroits où la ventilation ne fonctionne pas énergiquement. Après avoir accompli un trajet difficile à apprécier dans ce dédale de galeries, nous aboutissons dans une taille ou chantier d'abatage. Le torse nu, ruisselants de sueur, des ouvriers y travaillent sous une température des tropiques sans en jamais contempler le soleil. Les uns appliquent leur foreuse électrique contre la muraille qui scintille en mille endroits. Les mêches animées d'un rapide mouvement de rotation pénétrent profondément dans la masse de sel, y creusant des trous de mine qu'on charge de poudre noire comprimée. Les explosions provoquées à intervalles fixes font sauter des quartiers entiers de sylvinite que d'autres hommes armés de marteaux réduisent en morceaux plus faciles à manier. A pleines mains, ils empilement ensuite dans les wagons ces blocs qui semblent sertis de pierres précieuses de toutes les couleurs, allant du rubis à l'émeraude, de l'améthyste au jaspe.

En contemplant le rude labeur accompli par ces hommes au fond de cette mine de potasse, je songeai qu'en réalité j'avais devant moi des piocheurs de l'agriculture. Qui, en effet, calculera le nombre de tonnes de pommes de terre, de betteraves, la quantité de tabac, de coton et autres plantes de la grande culture correspondant, à chaque tonne de sylvinite extraite, pulvérisée, raffinée, et confiée au sol.

Mais je dus me rendre compte aussi que, dans la grande œuvre de solidarité humaine que représente la production agricole, la tâche qui incombe à ces hommes, peinant dans l'étouffante galerie percée à plus de 2000 pieds à l'intérieur de l'écorce terrestre, était mille fois plus pénible que la part du cultivateur de la surface, travaillant à la lumière du jour sous la grande voûte du ciel, pour aider la pluie, la rosée et le soleil à faire monter dans ses récoltes la potasse et les autres éléments de fertilité.

Pulvérisation et raffinage des sels de potasse.

Revenus au jour, ce fut ensuite le temps de faire la visite des installations de broyage et de raffinage des sels de potasse. Les blocs de sylvinite brute, déchargée des wagonnets qui remontent, sont d'abord introduits dans des broyeurs giratoires d'où la matière réduite en petits morceaux passe sur une courroie sans fin pour subir un premier triage consistant dans l'élimination, à la main, des débris de schistes détachés des parois par les explosions et mélangés au minerai.

Celui-ci est alors envoyé dans des pulvérisateurs ordinaires, et le produit, finement moulu, est mis en entrepôt en vue d'être expédié directement à l'état de sels bruts de potasse; ou bien on le dirige sur l'usine de raffinage à l'effet d'être converti en chlorure de potassium concentré et en sulfate de potassium.

Le principe du raffinage est basé sur la solubilité plus grande du sulfate de potassium à chaud comparativement au sel de cuisine ordinaire, lequel se dissout dans des proportions ne variant guère avec la température. C'est pourquoi la sylvinite est traitée par de l'eau chaude jusqu'à obtention d'une solution saturée qu'on laisse refroidir dans des séries de grands bacs, appelés bassins de cristallisation.

Aussitôt que la solution se refroidit, le chlorure de potassium commence à se déposer, sous forme de cristaux, sur le fond des bacs, tandis que le chlorure de sodium se maintient en dissolution. L'eau mère est décantée et sert au lessivage de nouvelles quantités de sylvinite dont elle n'enlève plus alors que du chlorure de potassium. Pour obtenir du sulfate de potassium, on traitera le chlorure raffiné par de l'acide sulfurique. Ceci explique que la potasse en l'état se sulfate revient toujours plus cher par unité qu'à l'état de chlorure.

Organisation commerciale et technique.

Actuellement, le bassin des mines de potasse d'Alsace possède dix-sept puits d'extraction, la plupart complètement équipés. Les trois groupes de mines allemandes à l'origine, et placées provisoirement sous l'administration du séquestre du gouvernement français, se sont réunies au groupe contrôlé, dès le début, par des intérêts français, pour la vente de leurs produits, en un organisme commercial portant le nom de *Société commerciale des potasses d'Alsace.*

Cette société traite les marchés pour l'ensemble des mines et répartit entre elles

utes les commandes. De plus, elle s'est ljoint un organisme technique et de ropagande nommé: "Bureau d'études sur s engrais", ayant son siège principal à ulhouse et dirigé aijourd'hui par monsieur uis Hautmont, ingénieur agronome.

Depuis sa création, ce Bureau d'études a ganisé dans toutes les régions de la France nombreaux essais afin de démontrer ce ue les agriculteurs sont en droit d'attendre un emploi judicieux des engrais potassiques, lvinite, chlorure de potassium et sulfate de tassium. Ces expériences ont été entreises le plus souvent sous le contrôle direct s Directeurs des services agricoles, des prosseurs d'agriculture ou d'instituteurs argés de cours post scolaires agricoles.

Il est à remarquer aussi que, dans ces essais, est fait usage non seulement d'engrais potasques, mais encore de combinaisons diverses engrais phosphatés et azotés et cela dans le ut de trouver la recette la plus profitable ur la fertilisation du sol. Le Bureau étude possède tout un matériel de démonration, disposé dans de grands camions tomobiles qui circulent par toute la France; agronome compétent les accompagne et nne des conférences avec projections luminses et cinématographiques dans les centres ricoles visités par cette école ambulante. fin, le même organisme publie encore des cts et des bulletins expliquant le rôle et méthode d'application des engrais chimites en général et des sels potassiques en rticulier.

ngrais potassiques mis sur le marché par l'Alsace.

Les engrais potassiques mis sur le marché r l'intermédiaire de la "Société commerciale s potasses d'Alsace" peuvent se résumer aux es suivants:

La sylvinite ordinaire: dosant de 12 à 16% de potasse pure ou oxyde de potassium. (K_2O).

C'est le sel brut provenant des gisements inférieurs, à l'état simplement pulvérisé.

La sylvinite riche: dosant de 20 à 22% de potasse pure (K_2O). Représente le sel brut tiré de la première couche, la plus riche en potasse, ainsi qu'on l'a vu.

Le chlorure de potassium dosant 50% de potasse pure (K_2O). C'est un produit raffiné contenant environ 80% de chlorure de potassium (KCl) pur.

4o Le chlorure de potassium dosant 60 à 62% de K_2O. Représente le produit pratiquement pur, titrant de 95 à 98% de chlorure de potassium (KCl). Il s'emploie plutôt dans l'industrie chimique que dans l'agriculture.

5o Le sulfate de potassium: dosant de 48 à 52% de potasse pure (K_2O). Provient donc d'une transformation du chlorure potassium en traitent celui-ci au moyen de d'acide sulfurique ou huile de vitriol. On sait que le sulfate doit être préféré au chlorure pour certaines cultures.

Engrais potassiques d'Alsace comparés à ceux d'Allemagne.

S'il n'y a pas de différence sensible, en ce qui concerne la qualité, entre les sels potassiques raffinés, chlorure et sulfate de provenance Alsacienne ou Allemande, par contre, on peut affirmer que les sels potassiques moins concentrés, et notamment les sylvinites, originaires d'Alsace sont nettement supérieurs. En effet, la seule impurité que renferment pratiquement les engrais potassiques du bassin de Mulhouse est du sel de cuisine ordinaire (NaCl) en proportions variables, tandis que les différentes catégories de minéraux potassiques bruts provenant des mines de l'Allemagne centrale, tels que la kainite, contiennent toujours des proportions considérables de chlorure ou de sulfate de magnésie, composés très nocifs pour les plantes. Aussi est-on obligé d'observer beaucoup plus de précautions dans l'emploi des sels potassiques non raffinés d'origine allemande. C'est ainsi qu'il faut les appliquer très longtemps d'avance, dès l'automne pour bien faire, afin que l'eau des pluies et de la neige ait eu le temps de dissoudre les malfaisants sels de magnésie et de les entrainer dans les drains ou les profondeurs du sous-sol, avant le départ de la végétation.

Ceci nous amène donc à émettre une idée en matière de conclusion à ce petit compte rendu de notre intéressante visite aux mines de potasse d'Alsace, c'est que le cultivateur de la province de Québec, en accordant la préférance à ces engrais potassiques plutot qu'à ceux originaires d'Allemagne, contribue non seulement au relèvement économique de la France, son pays d'origine, si cruellement éprouvée par la guerre qui lui fut imposée, mais agit encore dans son propre intérêt.

Amendments to C.S.T.A. "Who's Who"

The following Additions and Alterations should be made, in the space provided for that purpose, by all those who have copies of the C.S.T.A. "Who's Who." No other Notice of these Changes will be sent out.

Page 23, Klinck, L.S. Honorary LL.D., University of Western Ontario, 1924.

Page 25, Reid, W. J. Now farming in Prince Edward Island.

Page 26, Ruddick, J. A. Honorary LL. D. Queen's University, 1924.

Page 26, Spencer, J. B. Change lines 5 and 6 to read as follows: "Live Stock Commissioner, 1905-1910; Editor, Dom. Publications Branch, Dept. of Agriculture, 1910-1913, Editor and Chief, 1913-1917; *Director of Publicity*," etc.

Page 27, Anderson, C. G. Graduated University of Saskatchewan 1924, (B. S.A.). Now employed by United Grain Growers Ltd., Calgary, Alta.

Page 30, Chagnon, S. J. Awarded Quebec Dept. of Agriculture Scholarship, through C.S.T.A. 1924. Now taking graduate work in Animal Husbandry at Iowa State College.

Page 36, Jones, W. N. With the Albert Dickinson Company, Chicago, Ill. (Chief Animal Nutritionist).

Page 48, Toupin, G. Married.

Page 61, Hockey, J. F. Transferred to Dom. Lab. of Plant Pathology, Kentville, N.S. 1924.

Page 64, Major, T. G. Married.

Page 65, Richardson, J. K. Married.

Page 66, Simmonds, P. M. Graduate work at University of Wisconsin, 1924-1925.

Page 70, Gandier, S. H. Appointed Principal, Agricultural School, Claresholm, Alta. 1924.

Page 97, McOuat, J. E. Appointed Principal, Intermediate School, Kenogami, P.Q. 1924.

Page 98, Saville, H. Appointed Superintendent of Visual Instruction, charge of Motion Picture Branc Bureau of Publications, Regin Sask. May, 1924.

Page 104, DuPorte, E. M. Member of Amer can Society of Zoologists.

Page 105, Hammond, G. H. With Dom. E tomological Lab. Hemmingforc P.Q. 1921. Now completing gra uate work at Macdonald College

Page 109, McLaine, L. S. Married.

Page 110, Sanders, G. E. General Manage New York Insecticide Co., Medin N.Y. since 1924.

Page 111, Spencer. G. J. Appointed Assis ant in Entomology, Dept. of Zo logy, University of B.C. 1924.

Page 113, Treherne, R. C. Died at Ottaw June 7th, 1924.

Page 117, Bredin, J. H. Graduate work Agricultural Economics. Unive sity of Minnesota, 1924-25.

Page 119, Chapman, L. T. Appointed to sta of Dom. Experimental Statio Lacombe, Alta., 1924.

Page 120, Croskery, W. M. Transferred Uxbridge, Ont., 1924.

Page 122, Fidlar, D. G. Insert after "192 in 5th line, "Dist. Rep. under Sas Dept. of Agriculture, June 1922

Page 126, Hay, A. L. Married.

Page 127, Lamarre, A. Married.

Page 132, Michaud, G. E. Appointed Dis Rep. under Sask. Dept. of Agr culture, 1924. Now located Prince Albert, Sask.

Page 134, Neely, R. W. Appointed Asst. Se retary, Statistics Branch, Sas Dept. of Agriculture, May, 192

Page 138, Proulx, R. Transferred to Huntingdon, P.Q. May, 1924.

Page 139, Richards, A. E. Graduate work in Economics, Univ. of Wisconsin, 1924-1925. Also insert, "Military Service" in line 1.

Page 139, Richardson, B. B. Now in commercial work at Oxford Mills, Ont.

Page 149, Clark, T. O. Cancel words following "Edmonton" in line 7. Now in insurance and farming.

Page 154, Hatch, E. C. Change "Sifton" to "Clifton."

Page 156, Laurie, D. M. Married.

Page 162, Charbonneau, R. P. Change date of birth to 1899.

Page 167, Matthews, V. Appointed Superintendent, Dom. Exp. Station, Scott, Sask. 1924.

Page 168, MacKenzie, N. D. Resigned 1924. Now farming at Galt, Ont.

Page 169, McKillican, W. C. Appointed Dean of the Faculty of Agriculture, University of Manitoba, 1924.

Page 173, Bayfield, E. G. Obtained M.S.A. (McGill) 1924. Now Field Husbandman, Agr. School, Claresholm, Alta.

Page 177, Cutler, G. H. Graduate work in Economics, University of Wisconsin, 1924-1925.

Page 178, Derick, R.A. Appointed, Asst. Supt. Dom. Exp. Farm, Brandon, Man. 1924.

Page 182, Hanna, W. F. Awarded Fellowship in Plant Pathology, University of Minnesota, 1924-1925.

Page 183, Harrington, J. B. Change address to University of Saskatchewan, Saskatoon.

Page 186, Lamb, C. A. Obtained M.S.A. (McGill) 1924. Now on staff of Dom. Exp. Farm, Charlottetown, P.E.I.

Page 188, Moe, G. G. Graduate work, Cornell University, 1924.

Page 192, McTaggart, A. Married; also add "Military Service" in line 1.

Page 195, Raymond, L. C. Obtained M.Sc. (Wisconsin) 1924.

Page 208, Danby, G. In line 2, change "1909-10" to "1909-19".

Page 209, Fulton, A. Appointed Asst. to Dom. Fruit Commissioner 1924.

Page 210, Howitt, M. H. Married.

Page 213, Macoun, W. T. Awarded C.S.T.A. Fellowship 1924.

Page 214, MacAloney, Miss M. L. Married. Now resident in U.S.

Page 220, Skinner, C. T. Married.

Page 223, White, E. W. Insert in line 6 after word "Islands" the following: "1912-17, *District Horticulturist*".

Page 224, Amos, L. Change address to Vermilion, Alta.

Page 229, Laughland, F. Change address to Killarney, Man.

Page 236, Fry, H. S. Transferred from Winnipeg office of Farmers' Advocate to London, Ont., May 1924.

Page 239, McKean, A. F. Now farming at Rouleau. Sask.

Page 246, Hetherington, S. J. Graduate work in Marketing, University of Wisconsin, 1924-1925.

Page 266, Robertson, G. Change date of birth to 1878.

NOTE:

The foregoing is the first list of changes that has been published since the "Who's Who" was distributed in April, 1924. It is not complete and further lists will appear in *Scientific Agriculture* from time to time.

The General Secretary will appreciate immediate notification from Members, of any changes which should be made in their biographies, so that these may be included in the next list.

Concerning the C.S.T.A.

C. S. T. A. FORUM

It will be noted that the Section of this magazine which was introduced last month, under the above heading, does not appear in this issue. Readers however, will find on page 218 a statement by Mr. H. S. Arkell, Dominion Live Stock Commissioner, which continues and enlarges upon the discussion of agricultural policy iniatiated last month under the title "Duplication."

An open discussion of any subject and particularly one of a controversial nature is a good thing. For that reason it is to be hoped that members and particularly those in administrative positions will take advantage of the opportunity offered by this magazine of bringing their views and criticisms to the attention of fellow workers.

SPECIAL OFFER

The Macmillan Company of Canada offers to members of the C. S. T. A. two sets of Bailey's Standard Cyclopaedia of Horticulture (old edition), published in six volumes, at a bargain price of $20.00 f.o.b. Toronto. The original list price was $48.00 and the set has been kept up-to-date by frequent additions and alterations. Orders at the above special price must be placed through the office of the General Secretary and the first two orders received will be referred to the publishers.

A new edition of the above work is under consideration but will be available only at the regular list price.

MEMBERSHIP FEES

It is almost certain that at the June Convention a recommendation will be made to the effect that the present annual renewal fee of $6.00 be reduced to $5.00. Coupled with this recommendation it will be further suggested that the present entrance fee of $10.00 be maintained, but that it shall be made up of an iniatiation fee of $5.00, plus the regular annual fee.

Members will appreciate the fact that a reduction of $1.00 in their renewal fee means, under present conditions, a reduction of $750.00 in the annual revenue of the Society, and throws that additional financial burden upon the official organ.

The magazine has been self supporting ever since the Society assumed ownership in 1921 and in 1922 it enabled the Executive to reduce the annual fee from $10.00 to $6.00.

If a further reduction of $1.00 becomes effective next June, some measure will have to be introduced to ensure a more prompt payment of fees than heretofore.

There appears to be a tremendous psychological difference between $6.00 and $5.00 and the reduction of $1.00 now under consideration would probably have a more stabilizing effect than the reduction of $4.00 in 1922.

APPLICATIONS FOR MEMBERSHIP

Gibson, W. H. (McGill, 1913, B.S.A.) Indian Head, Sask.

Whyte, G. G. (Toronto, 1905, B.S.A.) Regina Sask.

Winters, Laurence M., (Minnesota, 1919 B.S.; Iowa, 1920, M.S.) Saskatoon, Sask.

NOMINATIONS

Local Secretaries are reminded that nominations for President, two Vice-Presidents and Honorary Secretary of the C.S.T.A., to assume office at the Edmonton Convention must reach the General Secretary by March 31st.

All nominations must be endorsed by the signatures of at least ten members.

Election ballots will be mailed to all members of the Society on April 10th.

Cytological Conditions in Wheat in Relation to the Rust Problem.*

W. P. THOMPSON

University of Saskatchewan, Saskatoon.

The importance of the cytological aspects f this problem lies in the fact that they are esponsible for the extreme difficulty of comining in a hybrid the rust-resistance of cerain *durum* and emmer varieties with the necssary qualities of *vulgare* (bread) wheats. hese *durum* and emmer varieties are the only nes which are resistant to all the biologic orms of stem rust which have so far been ound by Mr. W. P. Fraser and Miss M. Newon in their work at Saskatoon. They should herefore be used in the breeding work.

The difficulty in transferring their resiance to bread types was reported by Dr. H. . Hayes and his associates. They found that lmost all their resistant hybrids in crosses etween a *durum* and a *vulgare* wheat were f the *durum type.* I have found that in the econd hybrid generation of the cross between he resistant Iumillo and the susceptible Marquis, the ratio of susceptible to resistant was bout 13:1. This involved the raising and ndividual testing of more than 3000 F_3 amilies (about 30,000 plants in all). Of he more than 200 resistant F_2 plants and F_3 amilies, only 3 might be called *vulgare* types, nd they were not so resistant as the Iumillo arent.

There is thus a very high degree of correation between rust-resistance and *durum* haracters. But really this is only one phase f a more general correlation. In reality all he *durum* characters including resistance are orrelated and all the *vulgare* characters are orrelated. In order to prove this statement, would be necessary to consider much statisical evidence. This evidence I presented a month ago at the meeting of the British Association for the Advancement of Science in Toronto. Here I can only summarize one part of that paper.

We took 13 of the characteristics which distinguish the *durum* variety Iumillo from the *vulgare* variety Marquis and noted the condition of the second and third generation hybrids with respect to each of the 13 characters. It was then found that most of the second generation plants had either mostly *durum* characters or mostly *vulgare* characters. If it were an ordinary Mendelian case, the great majority of plants should show fairly equal mixtures of *durum* and *vulgare* characters. The distribution should have been as in the table below if no intermediate characters were present:

The middle terms are very large and the curve which expresses this frequency rises very steeply to the middle. But for the numbers actually found the curve is low in the middle and rises towards the ends. Plants with all 13 characters *durum* were found in a population of 50 whereas on a Mendelian basis it should require over 7000. In other words, the ordinary Mendelian laws of heredity do not apply in these wide crosses and most of the offspring have *durum* characters chiefly or *vulgare* characters chiefly. Moreover those plants which have approximately equal numbers of *durum* and *vulgare* characters are highly sterile, and their offspring

*Paper read at the Cereal Rust Conference held at Winnipeg, Sept. 9-10, 1924, under the joint auspices of the Federal Department of Agriculture and the National Research Council.

No. of durum characters	13	12	11	10	9	8	7	6	5	4	3	2	1	0
No. of vulgare characters	0	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of F_2 plants ..	1	13	78	286	715	1287	1716	1716	1287	715	286	78	13	1

are chiefly of the *durum* or *vulgare* type (not intermediate). A similar correlation has been demonstrated by Sax for 5 or 6 characters in another *durum-vulgare* cross.

The reason for this correlation is found in the cytological conditions and behaviour in wheat. The different species of wheat have their chromosomes in multiples of 7, as shown by Kihara, Sakamura and Sax. *Durum* has 14 in its reproductive cells and *vulgare* has 21. Both have of course double those numbers in their body cells. The first generation hybrid has an intermediate number and when its reproductive cells are being formed certain abnormal events take place which cannot be described without illustrations. They are, however, known to occur in other cases of hybrids between parents which differ in chromosome number. They consist essentially of the failure of some chromosomes to find mates and their wandering undivided to one of the daughter cells at the second division.

As a result of these processes nearly all the second generation should have a chromosome number intermediate between *durum* and *vulgare*. Only 1 F_2 plant out of 8000 should have 14 or 21 chromosomes. Last summer I made counts of chromosome numbers on a large family of F_2 plants and found that actually nearly half had 14 or 21, the rest having an intermediate number. Evidently there is a large elimination of reproductive cells with intermediate numbers. This causes also the partial sterility of the hybrids. Apparently a complete set of 7 is necessary for a balanced condition which is viable. Sax made counts on F_3 plants and found the proportion of plants with 14 or 21 chromosomes to be still higher. An element of choice may have entered here or a further elimination of intermediate reproductive cells has occurred.

There are two possible interpretations of the relation between these chromosome conditions and the correlation of characters and sterility:

(1) Unbalance:—Unless the chromosomes are in complete sets of 7, an unbalanced condition is present which is unhealthy. The cells with the extreme conditions of unbalance are not viable. Therefore the 14 and 21 chromosome cells are the ones which function for the most part and the F_2 plants sh those numbers. On this basis the differe between *vulgare* and *durum* wheats depe on the extra chromosomes, and a 14 chro some hybrid is a *durum* even if all its ch mosomes came from the *vulgare* parent. A plants with intermediate numbers wh come through the second generati are later eliminated and only 14 a 21 chromosome lines persist. The chromosome ones are the *durum*-like hybri and the 21 chromosome forms are the *vuga* like ones.

(2) Incompatibilities:—The *durum* ch mosomes must be very different from t *vulgare* ones. The two species have been existence since prehistoric times. The gene evidence shows that there are great factor differences as between the two kinds of ch mosomes. It is not to be expected that mixture of the 2 diverse kinds can functi properly. If all or nearly all the chrom somes are *durums* a properly functioning sy tem will result, or if all are *vulgares*. But mixture results in incompatibilities and d harmonies. You can take a Ford car pieces and may be able to put it togeth again. You can treat a Studebaker similar But you cannot build up a car which will r from a mixture of parts of the two. Sim arly if all the chromosomes are *durums*, if all are *vulgares*, a viable system result but if there is a mixture, incompatibiliti and disharmonies become evident. And wh all the chromosomes are *durum*, all the cha acters are *durum*. It may be possible to ha 1 or 2 *vulgare* chromosomes and the re *durums*, but more than that is too disturbin On this basis it would be possible, as actual found, to get 1 or a few *vulgare* characte in a segregate which is otherwise *durum*-lik or 1 or few *durum* characters in a segrega which is otherwise *vulgare*-like. I have, i the paper referred to, brought forward co siderable evidence that this matter of incon patibilities and disharmonies is as impor ant as the unbalanced numbers in causing th correlation of characters.

The bearing of this on the problem of pr ducing rust-resistant hybrids is obvious. W have not yet broken the correlation betwee rust-resistance and *durum* characters. D Hayes has *vulgare*-like hybrids with a co

derable degree of resistance. But according my observation they are not so resistant as e *durum* parent. My own resistant *vulgare*-se hybrids in the Iumillo x Marquis cross e not so resistant as Iumillo, though they ay be resistant enough for practical uses. It ems to be possible to transfer a portion only the resistance over to *vulgare* types because e resistance of Iumillo depends on more an one factor. That is indicated by the enetic ratios. We have probably got only of those factors in association with *vulgare* ctors, and owing to the difficulty of intro-ucing more than 1 or 2 *durum* chromosomes to the *vulgare* set, it will probably be very ifficult to introduce the other genetic factors n which Iumillo resistance depends. Much more work should be done either to prove or disprove this possibility.

The difficulty will be still greater in using the variety Khapli which for pathologic reasons we should like very much to use. In this case the disharmonies are still greater because it is impossible to bring even a first generation plant through to maturity and the setting of seed. It is hoped by some that it may be possible to get the desired result by first crossing Khapli with another emmer or *durum* and then one of the segregates with a *vulgare* type. One fears, however, that even after this detour it may be found that all the Khapli chromosomes must be present to produce viable forms.

Our Present Knowledge of Abortion and Bovine Tuberculosis.*

R. L. CONKLIN

Macdonald College, P.Q.

No one interested in the live stock indus-y needs an introduction to the two diseases be discussed in this paper. The farm upon hich tuberculosis has appeared usually ex-eriences abortion as well. Herds which have een upon the show circuit, and those cattle orced for production must suffer, sooner or ater, from lowered resistance. Environ-ent which lowers the animal's resistance in-vitably invites disease, and one cannot doubt he evidence shown, that our unnatural ousing, breeding and milking practices bear ome relation to existing diseases.

There is a formula, D=V/R, taught medical and veterinary colleges, which hould always be borne in mind when deal-ng with any disease. In this formula D is he disease, V, the virulence of the infecting rganism, and R, the resistance of the individ-al. From the practical point of view one eeds no better illustration of the working rinciple of such a formula, than the one ffered by tuberculosis and abortion. The isease may vary as V/R varies; the greater he virulence the less the resistance and therefore the greater the losses from the disease. The reverse also will hold true.

PART I—ABORTION

Much has been said and written concerning abortion and its causes since Bang and Stribolt discovered *B. abortus*. To be classified as a specific infectious disease, there must be a specific organism producing a definite chain of symptoms and lesions. It should also be possible to isolate the organism from all cases and to produce the disease in experimental animals, from which the organism must be again isolated. All of these things are said to have been accomplished by the "Bang abortion enthusiast".

Among the research workers who support the theory that "the Bang abortion organism is the sole cause of the disease called contagious abortion," are Stockman, McFadyean, Hart, Birch and Gilman. The statements of Birch and Gilman, regarding the specificity of *B. abortus*, are about the most

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emphatic of any yet published. They are, however, open to much criticism.

There is another group of workers who do not accept the view mentioned above. They believe that there are many organisms capable of producing the act of aborting. In the confirmation of their opinions, all laboratory workers must admit that there are many organisms associated with *B. abortus* in the majority of abortions. Laboratory men are so intent upon their search for *B. abortus* that they are disappointed if they fail to find it.

No laboratory worker has taken the trouble to give a detailed report of all of the organisms found associated with the cases of abortion under observation. We do not know the relative value of many of these organisms nor their symbolic value in relation to *B. abortus*. Nor do we know whether the act is brought on by the other organisms, hastened by their presence or retarded. There are but a small percentage of cases from which pure cultures of *B. abortus* have been isolated.

Among the questions which are not answered by the "contagious abortionist" are the following: (a) Why should all abortions from which *B. abortus* cannot be isolated be classed as not important? (b) Should we overlook the importance of the male in our breeding operations? (c) Is it not necessary to consider the physiology of reproduction in relation to our breeding difficulties?

There are many cases of herds where a high abortion rate has occurred but where *B. abortus* could not be recovered the cases received little attention. Many of these farms have treated animals with nostrums and since at the next period of parturition the animals calved physiologically, the nostrum received the credit. Since this phase of the question will be dealt with later it is sufficient to mention its possibilities at this time. This type of the disease is mentioned here to emphasize the importance of the herd control where *B. abortus* has not been isolated.

It is a well known fact that upon the examination of the gentalia of the female by histological methods, many abnormalities may be observed. One may locate atresic ova, cysts, and corpus lutea in various stages of degeneration. In the examination of spermatozooa of the male, many cases of m formed cells are observed. The writer wo like to suggest the union of weak or malfor ed germinal cells as the cause of many of early abortions which the clinician observ If the cells which unite to produce the fe are not absolutely healthy and vigorous, h much resistance has the resulting product the union? With any infection at all prese in the generative tract, a fetus of this ty dies much earlier. Further, one might co pare these early abortions to the developm and early death of the germinal cell of t hen's egg. It is an established fact that ma eggs appear fertile at an early date, but th the germ dies long before the date at whi they are supposed to hatch. There is doubt that the same thing occurs in the ca of larger animals but since we are unal to candle the uterus and to determine t exact time of the death, this phase of t problem is overlooked.

It is the early abortion and the ones which *B. abortus* cannot be located whi discourage the average farmer. He has be told by the laboratory worker that he has n a disease of any consequence and that he ne not worry. Factors which do not worry t laboratory man, then, should not worry t farmer though he observe a high percenta of abortion and the subsequent losses throu loss in production, flesh, and slow breedi or even sterility. These early abortions a said to take place before the localization *B. abortus* takes place. It is stated that th establishment of *B. abortus* does not tak place before fifty-eight days. A chec upon the nature of the abortion might poi toward the theory already advanced, and th death and expulsion of the fetus may be e plained by the formula given, D=V/R.

The male of the bovine species has escape the criticism of the majority of the researc workers. Being free from suspicion, man impotent, possibly infected, or sterile sire have been allowed to copulate freely with out being obliged to pay the penalty for thei sins. Fortunately for the animal industr Williams undertook to study the rela tion of the bull to breeding disturbances. H was able to demonstrate very conclusively, th importance of this vital factor in breedin

fficiency. The histo-pathological phase of ne investigation suggested by the work of Villiams was carried out by Gilman.

In order to emphasize the importance of ne bull in regard to the herd efficiency, two pecific cases will be mentioned. In case 1, even abortions had occurred during the year. he attending veterinarian had diagnosed contagious abortion' and the entire herd had een treated with biological products, (vac- ines and bacterins). A study of the herd ecords revealed the fact that, with one ex- eption, all of the abortors had been bred to ne bull, while those animals bred to other ulls had calved physiologically as far as ould be determined. There had been three ulls used in the herd. The bull appeared o be perfectly healthy upon external physical xamination. He was a quick breeder and al- ways appeared anxious. Rectal examination id not reveal any pathological changes of he organs palpated. The semen was collect- d and examined after the method of Wil- iams. The spermatozooa stained poorly, ere few in number and sluggishly motile. pon further study many of the spermatozooa ere found to be tailless, and the heads of any were indented or badly shaped. There as an abundance of shreds of tissue and acteria present in the semen. The bull was ondemned as a worthless breeder.

In case 2, the herd sire had been condemned year previously as a dangerous breeder. ll animals bred to this bull exhibited a evere vaginitis which was cleaned up with ifficulty. Many females became sterile as result of the infection obtained in this anner. The young bull which had been sed to follow the old herd sire, was an ex- ellent sire. He had a breeding efficiency of bout 90% for the early part of his career, hich shows that nearly every cow was "set- led" at one service. Later in the year many f these cows were known to have aborted or o have given birth to malformed calves or etuses. These early abortions and the mal- ormed fetuses are presented as evidence of eak germinal cells, the abortions resulting eing due to the inability of the fetus to ompete with its surroundings. This bull eveloped epididymitis and seminal vesiculi- is on one side. It became necessary to emove the diseased testicle and its append- ages. The testicle weighed six and a half pounds and measured 14½ by 8 inches. A pathological and bacteriological study of the tissues is to be made.

With the present day uproar relative to abortion, every breeder is anxious to know just how many infected animals he may have. The man who is purchasing cattle asks the farmer concerning 'contagious abortion' in his herd and what answer does he receive? No one except the laboratory worker can tell him whether or not his herd is infected, and how much does the laboratory worker know about it? We do know that the 'cantagious abor- tion' supporter, and those who manufacture or dispense the biological products (bacterins or vaccines), recommend the use of the blood test (agglutination test) for the purposes of diagnosis.

It is an accepted fact that all animals which react to the blood test do not abort nor do all animals which abort react to the blood test. Even these facts do not discourage the friends of *B. abortus*. Later it was shown by Evans that it is impossible to dif- ferentiate *B. abortus* from either *B. militensis* which produces malta fever of goats, and from a rod shaped organism which occurs in cases of fistulous whithers of horses. If it is not possible to distinguish between these organisms in the laboratory, and if the 'blood test' gives no definite information as to the status of an animal in its relation to the possibilities of aborting, wherein is the value of this work to be found? We must have some tangible evidence of the practical ap- plication of the laboratory work with the agglutination test and the uses of the vac- cines and bacterins if they are to be continued in the service. Why should the laboratory worker and the commercial house and the veterinarian interested only in the moment- ary financial return, continue to mislead the farmer and breeder concerning this condition?

It has also been stated that animals which have been treated with the vaccines (living cultures of the organisms) do not give a re- action to the 'blood test'. I maintain that, if this is true, the usefulness of the test is becoming more limited every day. With the number of men in the field today who are loading herds with these biological products, one will soon be able to buy cows which ac-

cording to the test are free from 'contagious abortion'. In reality, however, they will carry the infection of the Bang organism in their bodies due to the inoculation.

Vaccination as a means of prevention of a disease is logical in many cases as we all know, but with abortion we have a great many factors to consider which differ from those involved in other diseases. We are dealing with a condition and not a specific contagious disease. We must therefore consider the environment of the individual, her physiological condition, state of nutrition, diet, health of sexual organs and the sire as the chief factors in the elimination of the condition. The factors of sexual incompatability, impotency either partial or complete exist in other species as well as the bovine but are passed over since they are not of such great financial importance.

One reads in bulletins upon this subject,—"Vaccination is recommended for young unbred heifers and cows which have aborted". What is their value in these cases? What is the use of injecting the living organisms into an animal which they say is already infected? If the presence of the living organisms produces an immunity, why do they abort at all? It has taken many years to train *B. abortus*, yet some workers have evidently succeeded. Hart injected a number of animals to produce immunity and another lot to show the presence of *B. abortus* in the gentalia of those animals which abort. He succeeded in locating the organism in the generative tract of the animal which aborted but not in the one which he had treated to prevent the condition even though the injections were similar. One statement refutes the other and renders both worthless. Gilman and Birch have followed the same procedure in their work.

Any research worker who has kept accurate data upon his work with the vaccines has proven the worthlessness of these products. Hart and Carpenter in their paper upon controlled vaccination experiments, state that 30% of the unbred heifers used in their work and which were vaccinated remained sterile. They cannot account for the sterility in any other way than "results of the vaccination". A high percentage of sterility has been observed in herds in the Province of Quel where this method has been followed. the control animals of Hart and Carpent the unvaccinated animals showed no sterili Which is the better for the breeder, a 30 sterility among these young heifers or a lo rate of abortion with a possible breedi future? One may estimate the cost in eith case.

When the animals of a herd are vaccina ed one observes certain physical reactio such as, going off feed, animal stands hum ed up, loses condition, goes down in mi production, abcess formation about the si of the injection, and there is a slowness the return to 'heat'. It has been estimate that the non-treated animals give from 5 90 per cent. more milk for the given perio of lactation than do the treated animals u der the same conditions of care and feed.

To sum up the situation relative to the va cines, it may be said that those who a manufacturing, and those who inject the vaccines promiscuously, are in my opinio a menace to the live stock industry. To su port this contention it has been shown th (a) the 'blood test' gives little informatio concerning the possible breeding difficulti which an animal may experience, (b) th bacterins or vaccines may be of a differe strain from those producing the condition (c) they are injected into animals alread presumably suffering from the infection an (d) they do not allow the unsuspecting buy er any protection against the introduction o the so-called 'spreaders' of the disease, sinc those vaccinated do not react to the 'bloo test', and animals which abort frequently d not react, and when moved from one localit to another vaccinated animals frequentl abort.

That abortion is a self-limiting disease ha long been recognized by the veterinary pro fession, yet the condition is one that readil lends itself to commercial exploitation. Breed ers and farmers have paid thousands of dol lars into the coffers of these concerns fo drugs and products of all descriptions, whic they could have gotten along without hac they been properly informed. The farme and breeder need education along the line of dealing with this condition and it is here that the veterinary profession and the tech

ical agriculturist have fallen down. One looks for the financial return and the other accepts advertisements as printed in the agricultural journals. We need to get together, to get down to the farm level, and do some good logical reasoning upon the fundamental problems involved in this condition.

The practical methods of handling this condition do not rest with the biological products but with the dicta of Williams. To mention the essential parts of this method (which by the way is usually incorporated in the recommendations of the 'contagious abortionist'): (a) mate a sexually healthy male to a sexually healthy female; (b) good general care, feeding, hygiene of the stable in order to increase the individual resistance; (c) practice stable disinfection; and (d) care of the dam and calf at time of parturition.

It is a very good plan to raise all of your own stock, so far as you are able, since any addition you may make may not be resistant to the infection which you have on your farm, or your stock might not be resistant to the infection which the introduced stock may harbor. Additions should be of young stock only and bulls of a breeding age should have the semen tested.

In closing I would like to call your attention to the need of research work upon the breeding diseases of cattle. This project cannot be carried out without the help, support and cooperation of the farmer, breeder and veterinarian. Our interests are common yet there is a tendency to 'pull apart'. Steps should be taken to secure the necessary cohesion of our forces in order to improve the basic industry of this Dominion.

PART II—TUBERCULOSIS

Bovine tuberculosis has been known to exist among our animals for a great many years; in fact it is one of the most ancient of our known diseases. The causative organism and a test for the disease have been known for over a quarter of a century, yet with all the advances of science this disease has spread rapidly with civilization until now there are but few uninfected territories. No veterinary problem has received as much attention and publicity as that given to the eradication of tuberculosis among our dairy cattle.

The spread of this disease has been accelerated by the spread of the industry and the modern methods of farm practice and farm management. It has also been disseminated to new areas and to uninfected herds by the unscrupulous cattle dealer. Many men have knowingly sold cattle suffering from tuberculosis to an unsuspecting buyer. The other side of the case may be related by merely mentioning the owner who did not believe in the test and who kept the cattle that did react. The owner, himself, was not the only one to suffer in these cases, but the other members of the family and the young cattle on the farm.

The public has always taken it for granted that since the disease has existed for years, it must always exist. When vast numbers take a stand of this nature, little assistance can be obtained in any attempt to check the condition. The public has had the opportunity to know the exact nature of the disease but they have not taken it seriously and do not realize the menace of tuberculosis unless it strikes home. The question of public health has not been sufficiently emphasized in its relation to this disease. If tuberculosis is a contagious disease, why should an owner be allowed to dispose of a reacting animal in any manner which he might desire, as long as the test which divulges this information did not happen to be made by a Government Inspector? For the benefit and protection of all concerned a record of the disposition of all reactors should be kept.

The farm papers and dailies have carried articles on tuberculosis in dairy cattle which have often been misleading to the farmer. Many owners hold the opinion that an animal is not dangerous unless she is a 'piner', (a term applied to cattle exhibiting physical evidence of the disease). Little do they appreciate the fact that it is often the most sleek animal that is the greatest source of danger. They do not consider their families, their other cattle, swine, or poultry, as being exposed to the disease by the keeping of a reacting animal and the using of the milk from such an animal. If they would only stop to estimate the actual cost to the live stock on their farm, as exhibited by the experience of others, there might be a willingness to 'clean up the herd' early. They must

not be allowed to think that once they do have a clean test, their herd will remain clean indefinitely, else all will have been done in vain.

It is not only the farmer who needs education regarding the nature of tuberculosis and the milk from reactors, but the consumer as well. The assistance of each municipality is needed in the attempt to bring about the distribution of better dairy products. A great many of the common councils do not consider one man's milk any better than another and they are in this manner not encouraging the production of better milk, cleaner stables and healthier herds of cattle. They will not insist on pasteurization of milk from herds known to be infected, and the people will not purchase the pasteurized milk because they cannot see the cream line on the bottle. All of these facts show the need of education of the people as to the nature of this disease and the methods of combating the same. It is in the municipalities that we should start with our 'accredited herd plan' and work out from this centre.

The question most frequently asked by herd owners, considering the elimination of the disease, is—"Can we ever be sure that our herd is free from the scourge of tuberculosis?" Many owners of herds showing over 50 per cent reactors, have attempted to keep the remnants of such a herd and have found it possible to 'clean up'. Others have had a great love for some individual due to her show value, milk production, or her breeding propensities. Still others have 'plugged' animals to get them through the test. What is the net result? They and the surrounding countrymen, condemn everyone associated with the test, the biological products, and the Dominion official for inefficiency. They are never at fault for their lack of co-operation or for their poor sanitary conditions.

The time has come when some very definite measures should be taken in regard to the private test of dairy cattle, and the disposition of these reactors so located. We cannot afford to have these reactors and suspects, taken out by private test, shipped to other parts of the Province and to other parts of the Dominion to contaminate other herds. We must give the farmer, who has shown his interest in this work, all possible assistance and protection.

In our attempts at the elimination of this disease from our herds, I do not think that we should rely upon any one test nor should we make any one test the routine test for all herds. Conditions vary in every herd and in each community; therefore to lay down specific regulations for the carrying out of a test of this nature would be a factor against the success of the plan. Our veterinarians should be well enough qualified to size up the situation in individual herds and to apply the tests most suited to the existing conditions. Combination tests, which give a double possibility, should prove the most satisfactory. Single tests are unreliable and are apt to bring about some of the bad breaks which have been observed in this work.

It has not been many years since the intradermal test was introduced on this continent by Baker and Ward, but it has been accepted very generally. It has some advantages, since it has enabled us to test calves under six months of age and has made it possible for one man to test large numbers of cattle at one time. It has reduced the expense of testing large numbers, and especially range cattle. It has proven very satisfactory in herds where the subcutaneous test had been employed for years.

The drawback of the intradermal test may be explained by the lack of experience of the operator, non-specific reactions, poor technique, or as has been brought out recently by Hagan and Traum, the nature of the tuberculin employed. Many of these cases of no-lesion reacting cattle have led to the accusation of inefficiency of the veterinarian but may be explained by the work of the above mentioned authors.

Another phase of testing which has called for much investigation is the non-reacting tuberculous cow. In a series of experiments in herds where a large number of reactors had been discovered, a modification of the tests previously employed has given satisfactory results. In this method the regular method of testing is first employed. Five days after the regular test has been completed,

the intrapalpebral test and the ophthalmic test are used. This method of a follow-up test has given very satisfactory results in locating the latent reactor and in many cases the generalized case which has failed to react to the routine tests. A report of this method may be found in the *Journal of Agriculture* for May, 1924.

There has been much objection to the ophthalmic test because of the belief that it produced a local inflamation. This rarely occurs when the operator is experienced. This test is not interfered with by the subcutaneous or the intradermal tests, whilst with the latter two, one may interfere with the other. It gives much valuable assistance in the testing of cattle.

With the hurried methods of testing of today, we are overlooking a very valuable adjunct to the work, which was formerly employed. The physical examination of all cattle, formerly thought so helpful, has been practically discarded. There are many cases of generalized tuberculosis which do not react but which could no doubt be removed by an efficient physical examination. This idea of rushing about, apparently trying to see how many cattle one man can test in a month or a year, is going to lead us to grief if we are not careful. It is human to err, but how many more errors are committed by the rushing of a biological test? We might better proceed slowly and do our work well.

There is no better plan of elimination suggested than the 'accredited herd plan', and the efforts to carry on area work are worthy of the support of all interested. This procedure is more practical from every point of view than the old method of taking a herd here and there. It creates a better spirit of cooperation and therefore when the interest of all owners in a locality is aroused, it is the psychological time for a drive. It gives each individual more protection and creates a demand for cattle from that area. The testing can be done at the minimum expense, allows efficient disinfection and the carrying on of education at the same time.

In these areas, the farmer must be advised as to the probable losses in his herd as estimated from the herds already tested in his locality. He must be informed as to the benefits to himself and to his community and he must realize that once he has a clean herd, eternal vigilance is the price of keeping it clean. He should be advised not to purchase skimmed milk for the feeding of young animals at any price, for no one knows exactly how efficient the handling of creamery products may be at all times. Something may go wrong with the pasteurizing machine and one lot of such milk might be the undoing of years of labor to free one's animals from an infection, which can easily be returned to the farm. One of the greatest of research workers once stated that it would be possible to eradicate tuberculosis by the work and cooperation of the breeders only. Many are only now beginning to see what he saw many years ago.

In our present situation we must consider very carefully the methods of testing, the ability and honesty of the veterinarian and the owner, the willingness of the veterinarian to study the situation and to be honest with himself and the owner. Many owners accuse the veterinarian of finding reactors in order to protect his position and they also say that the inspector at the abbatoir protects the man in the field. Do the owners help to bring about a better spirit in the carrying out of this work? They do not give the veterinarian all of the essential facts, they withhold valuable information and cause the professional man to suspect every man of having something to cover up. If the 'accredited herd plan' is to be successful, we must seek a better understanding between the live stock owner and the veterinary profession. We must have experts to carry on the work and these experts must necessarily come from the veterinary profession as specialists in animal diseases and sanitation, but these men must show that they are qualified for the service which they are to perform. If they are capable and efficient, then there need be no fear of the animal husbandman forcing the hand of the profession and doing a part of the work which should fall to it.

Seven Varieties of Oats Eligible for Registration

A Promising New Variety Originated at Guelph.

C. A. ZAVITZ

Ontario Agricultural College, Guelph, Ontario

The estimated value of the oat crop of Canada, for 1924 is $208,752,000, and for Ontario, $61,310,000. There are more bushels of oats produced in the Dominion annually than of all other grain crops combined, including spring wheat, winter wheat, barley, rye, buckwheat, flax, peas and beans. In each of the Provinces, with the exception of the prairies, there is a greater acreage of oats than of any other crop. The oat crop of Ontario is about one-quarter of that of the whole of Canada.

Based on Dominion Statistics, the following table gives the provisional estimated average yields of oats per acre for 1924 and also the average annual yields per acre for the six years from 1918 to 1923 inclusive, for the different provinces of Canada:

	1924	Ave. 6 Yrs.
British Columbia	36.1	44.3
Ontario	40.0	36.0
Nova Scotia	32.8	33.3
P.E. Island	33.6	32.3
Manitoba	36.2	31.4
Saskatchewan	19.6	30.3
N. Brunswick	28.5	29.7
Alberta	28.6	29.6
Quebec	29.3	26.7

It will be seen that Ontario headed the list in yield of oats per acre in 1924 and also in the annual average for the six year period with the exception of British Columb which province, however, has a less acrea of oats than any one of twenty Ontario cou ties.

Each of the seven varieties of oats eligil for registration at the present time in Ca ada through the Canadian Seed Gro ers' Association has been under expe ment at the Ontario Agricultural C lege, Guelph, from fourteen to thirty-fi years. The following results are for t longest possible uniform period of time a are arranged in the order of the avera yield of grain per acre.

In the average results for the fourteen yea the yields of grain in pounds per acre, l the hulls, as determined from the tabulat results here presented, were in the followi order: O.A.C. No. 3, 2,069; O.A.C. No. 7 1,976; Abundance, 1,869; Alaska, 1,83 Gold Rain, 1,808; Victory, 1,784; and Ba ner, 1,765. The heaviest average weights grain per measured bushel were produced Alaska and O.A.C. No. 3, and the lightest Banner and O.A.C. No. 72. It was found th weight per measured bushel was influenc more by the length than by the quality the oat grains of different varieties. A varieties were free from lodging in ea of five to eight years and in the oth seasons, Gold Rain and O. A. C. No. 3 h the least, and Abundance and O. A. C. N

Variety	AVERAGE RESULTS FOR 14 YEARS				
	No. of Days to Mature	Height in Inches	Percentage of Hull	Yield per Acre Straw (tons)	Grain (Bushels by Weight)
O. A. C. No. 72	109.6	47.1	28.9	2.16	81.76
O. A. C. No. 3	99.4	40.9	24.7	1.89	80.82
Abundance	107.1	43.1	28.8	2.03	77.22
Gold Rain	107.0	42.1	30.1	1.88	76.06
Victory	108.7	41.8	30.3	1.82	75.30
Banner	109.6	44.2	30.4	2.13	74.60
Alaska	100.9	41.7	23.9	1.67	70.96

72, the most lodged grain. The amount of rust was slight and was influenced more by season than by variety. The freest from rust was O. A. C. No. 3 and the next freest, Alaska, the two earliest varieties. In each of the last ten years, determinations were made regarding the comparative size of the kernels and the results show that the largest grains were produced by Banner and Abundance and the smallest by O.A.C. No. 3 and Gold Rain. All seven varieties have spreading heads, and white grain with awns, excepting O.A.C. No. 3, which has awnless white grain, and Gold Rain, which has awnless yellow grain.

Short History of Each Variety

In the spring of 1891 Vick's American Banner oats were imported by the College from the introducers of this variety, James Vick's Sons, Rochester, New York. This name was later abbreviated to American Banner and still later to Banner. Various other lots of this variety have been obtained for experimental purposes from time to time from the United States, from Eastern and Western Canada and from different parts of Ontario. These have included seed from leading members of the Canadian Seed Growers' Association and from others.

Previous to 1902 each of one hundred and seventy-four named varieties of oats had been tested in our experimental grounds for at least five years, and ten of the best ones had been tested under similar conditions for twelve or more years. Of the white oats, a variety from Siberia was the most productive in the twelve years' tests, surpassing the Banner in quality of grain and in average yield per acre per annum by 3.9 bushels. Consequently the Siberian variety was used in 1903 in a large nursery plot in which nearly 10,000 seeds were planted by hand at equal distances apart. From one of the several selected plants from this nursery the O.A.C. No. 72 variety of oats was started.

The Ontario Agricultural College imported the Alaska from the United States in 1900, the Abundance from France in 1889, from Ireland in 1902, and from England in 1911, and the Victory from Sweden in 1911. The Gold Rain was imported from Sweden in 1911 by L. H. Newman, then secretary of the Canadian Seed Growers' Association and now Dominion Cerealist, and the College received some of this seed from him in that year. The O.A.C. No. 3 was started at the College from a single seed in 1902. This new early variety is now grown alone and also in combination with O.A.C. No. 21 barley for which it is well adapted. Ontario had 625,622 acres of grain grown in combination in 1924.

Experiments by Farmers

To study further the adaptability of new varieties for the different soils and conditions of the Province, an extensive system of co-operative experiments has been in operation through the medium of the Experimental Union for more than a third of a century, during which time over one hundred thousand distinct experiments have been made with farm crops. In connection with this work the O.A.C. No. 72 variety surpassed all other varieties of oats under test in each of eleven out of thirteen years. The O.A.C. No. 3 usually gave a lower average yield than the best of the late varieties, but in no year was it surpassed by an early variety. The Alaska was tested with other varieties on 96 farms in 1902, on 104 farms in 1903, on 187 farms in 1913 and on 141 farms in 1914, coming in direct competition with the O.A.C. No. 3 the last two years. As the Alaska was surpassed in average yield per acre by the O.A.C. No. 3 and by all other varieties, with but one exception, in one year, it was dropped from the co-operative experiments after 1914, but it has been included in the College experiments from 1900 to 1924 inclusive.

Various Competitions

Within the last eight years the Ontario Government has employed 161 selected men of experience to judge and award prizes for the best fields of oats in connection with the Standing Field Crop Competitions, organized through the medium of the Agricultural Societies of Ontario. The judges carefully examined the fields of oats under competition immediately before they were harvested, taking into consideration, yield and quality of grain, absence of lodging, vigor of growth, uniformity of maturity and freedom from diseases, insect injury, weeds and other grains.

Of the 1,108 first prizes awarded by these men in the eight-year period, O.A.C. No. 72 received 565; Banner, 307; Abundance, 21; Gold Rain, 13; O.A.C. No. 3, 4; Victory, 1; Alaska, 1; and all varieties not eligible for registration, 196. The early varieties such as O.A.C. No. 3 and Alaska had but few entries.

In the Standing Field Crop Competition the numbers of first prizes received by O.A.C. No. 72 and Banner in the eight-year period for the three divisions of Ontario, recognized by the Association of Agricultural Societies were as follows:

Variety	Western Ontario	Eastern Ontario	Northern Ontario	All of Ontario
O.A.C. No. 72	326	121	118	565
Banner	164	84	59	307

These two varieties received 84% of all the first prizes awarded for fields of standing oats in Ontario in 1923. There were, therefore, only 16% of the first prizes received by all other kinds, including the five remaining varieties eligible for registration in the Canadian Seed Growers' Association, and the four remaining varieties recognized as "standard" by the Ontario Association of Fairs and Exhibitions.

Practically all of the O.A.C. No. 72 oats which are now grown on thousands of farms throughout Ontario had their origin in the pound lots distributed for co-operative experiments through the medium of the Experimental Union. As the merits of the new variety became evident through the local tests on the individual farms, the small lots were increased quickly and economically. This new variety has had a very marked influence in reducing, to a large extent, the number of varieties of oats grown in this province.

In each of the past three years, Combined Standing Field Crop and Threshed Grain Competitions have been carried out through the medium of the Agricultural Societies of Ontario. Only two varieties of oats have been used in these competitions. The following gives the average number of points out of 100 obtained by each of these varieties in both the standing crop and the threshed grain for the three-year period:

Variety	Standing Crop (In the Field)	Threshed Grain (In the Barn)
O.A.C. No. 72	92.4	91.1
Banner	90.5	86.9

The Ontario Agricultural Societies hold four competitions with threshed grain annually. The number of prizes which were awarded to oats at each of these exhibitions in the past eight years, are shown in the following table:

Championships

The only exhibition at which championship prizes were offered for oats was the Provincial Winter Fair, and for the ten years, from 1915 to 1924, inclusive, the championship prize went to the Joanette in 1915, to the Banner in 1922, and to the O.A.C. No. 72 in each of the other eight years. It should be understood that all oat entries at the exhibition, including the open classes and those in connection with the Canadian Seed Growers' Association, as well as those from the Field Crop Competitions were eligible for the championship prize.

Variety	Canadian National Exhibition Toronto	Central Canada Exhibition Ottawa	Provincial Winter Fair Guelph	Ottawa Winter Fair	Total Four Exhibitions
O.A.C. No. 72	39	13	45	28	125
Banner	20	7	23	18	68
All other Varieties..	24	12	10	23	69

Judges

Either annually or biennially, the judges for the field crop competitions for Eastern Ontario have met two or three days at Ottawa, and for Western Ontario at Guelph, to prepare themselves more fully for the work of judging the oats, immediately before they were harvested. The judges for the seed grain competition, here referred to, were chosen about equally from Dominion and from Provincial officials, and for the Combined Field Crop and Threshed Grain Competitions mostly from Dominion men.

Conclusion

Of the seven varieties of oats eligible for registration in Canada, the best general records, for Ontario, have been made by O.A.C. No. 72 of the late, and by O.A.C. No. 3 of the early varieties.

Practical Results

According to Provincial and Dominion statistics the average yield of oats per acre per annum in Ontario for the last twenty-three years has been 2.4 bushels higher than for the two previous decades in spite of the fact that there is a tendency towards decreasing yields in a new country. This amounts to an increased production for the province, of 153,382,241 bushels, worth, at prices actually paid during these years, a total of $72,289,050. This splendid increase is largely due to the general use of better varieties, at first such as Siberian, Banner and Daubeney, and more recently still higher yields such as O.A.C. No. 72 and O. A. C. No. 3. The increases should be even greater as these high-yielding new varieties become more fully established and especially as still better varieties are introduced into general cultivation. Such varieties as Victory, Banner and Alaska even with registered seed, do not give the highest average yields over Ontario.

The New Variety, O.A.C. No. 144

A new variety of oats which has been named O.A.C. No. 144 has surpassed the O.A.C. No. 72, by an average annual yield of grain per acre of 6.4 bushels in the regular experiments at the College for seven years, of 4.3 bushels in a special triplicate experiment at the College for five years, and of 4.6 bushels in the co-operative experiments throughout Ontario in the two years, 1923 and 1924. It was included in definite co-operative experiments with other varieties of oats on 80 Ontario farms in 1923 and on 310 in 1924, and will be distributed for one-eightieth acre plots to farmers living in all parts of Ontario who ask for the oat experiment in the spring of 1925. The seed of this new variety is not yet available in large quantities.

The O.A.C. No. 144 is a tall, vigorous, broad-leaved, stiff-strawed, late variety of oats, which possesses a spreading head and a long, slightly brownish white grain practically free from awn and which produces a heavy yield of both grain and straw of good quality. Application has been made to the Canadian Seed Growers' Association that the O.A.C. No. 144 variety of oats be accepted as eligible for registration.

ERRATA

In the January issue of *Scientific Agriculture*, on page 139, an article was published by J. Auguste Pepin under the title "The Role of Calcium in Dunkirk and Volusia Soils," to which the following corrections should be made:

P. 140, par. 1, L. 1, change "Schreimer" to "Schreiner."

P. 140, par. 6, L. 2, change "ration" to "ratio."

P. 149, par. 4, L. 5, change "impossible" to "possible," so that the sentence reads—"It is possible, indeed, that most of the phosphate added in dilute solution to the limed soil has been absorbed by the soil colloids, just as in the case of the unlimed soil; etc."

Identification of Apple Trees by Leaf Characters.*

P. M. DALY

Central Experimental Farm, Ottawa.

Probably ever since the beginning of the commercial nursery industry there has been a justifiable complaint against trees being sent out which afterwards proved untrue to name. In some cases it may have been but a few trees among an order, or among a variety; in others, and fortunately more isolated cases, there has been substitution of a whole variety and, although the nurseryman on the average is honest and endeavours to fill his orders strictly to the letter, the instances where varieties untrue to name are sent out, or where substitutions are made, are the cause of no little annoyance and actual loss to the grower who receives them.

The inconvenience is all the greater since in the past it has not been possible to detect whether varieties are those which have been ordered until the tree commences to bear, a matter of four to seven years in most cases. There is also the added inconvenience of mixing of varieties; instead of straight rows of a variety, the grower finds himself confronted with a few odd trees here and there of an entirely different variety, which only multiply his picking difficulties.

There are many ways in which the mistake may occur at the nursery. In grafting, the scions may be exchanged or become mislaid, or, if the trees are budded, the budsticks may be incorrectly labelled. Scions may be taken in the nursery row from the wrong trees or from varieties other than those intended. There is the chance, though less likely, of mistakes occurring as the stock is lifted from the row. Finally mistakes may occur in shipping; a variety may be taken from the wrong bin or a label may be misplaced. Mention of actual substitution has been omitted since in but few cases does this occur where the substitution is not indicated by the labels. Most of the firms which carried on substitution without notifying the grower or indicating same on the labels have gone out of business and are not with us today.

Because of the inconvenience caused to the grower and the numerous ways in which mistakes may occur at the nursery, J. J. Thomas, a nurseryman himself, studied tree characters, publishing his observations, but his work received little attention for some time. The next man to undertake a study of the different varieties was Dr. Shaw, who started work on the different characters exhibited by the leaves of the various varieties in 1915. Dr. Shaw continued his study of leaves until 1922, when he published the result of his seven years' work, which comprised twenty-six varieties.

At the Central Experimental Farm a start was made in the study of apple leaves in 1919, when a collection was made of the leaves of various varieties as they grow at various points, from Kentville, N.S., to Sidney, B.C. In 1923, following the publication of Dr. Shaw's work, a beginning was made based on the lines on which he worked. A definite study was made of all the characters exhibited by the leaves of each variety and over twenty different features were distinguished and carefully studied. Because the chief concern of the fruit grower in this section of the country is the apple, since the Vineland Experiment Station is concentrating on the tender fruits, and because of the difficulty of securing an adequate collection of fresh leaves of tree fruits, other than the apple, at Ottawa, it was decided to concentrate on apple varieties alone for the present.

Having given in detail some of the reasons for undertaking the study of apple leaf characters and a brief statement of what has been done to date, perhaps it might be of interest to set down something of the manner in which a leaf is studied and to state some of the actual differences between leaves of different varieties.

*Paper read before the Quebec Pomological Society, December, 1924.

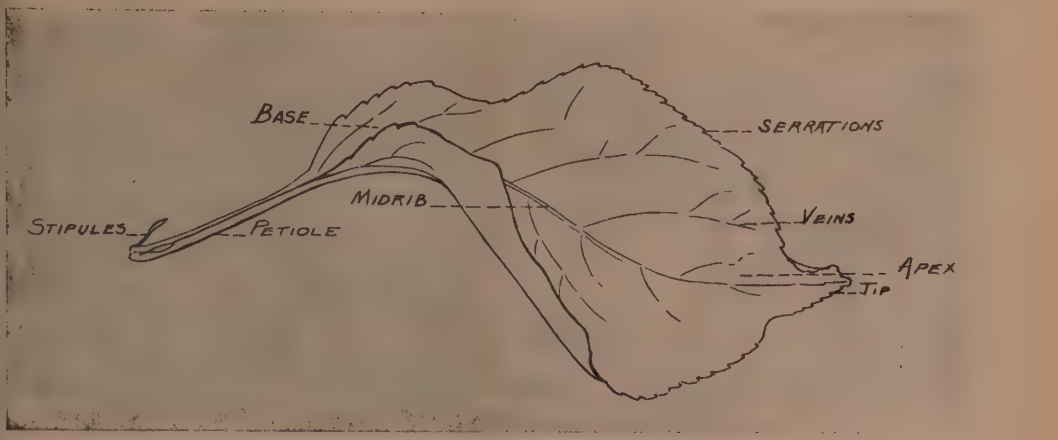


Diagram of Wealthy Leaf, showing parts.

Leaves for study are taken from fully grown ees, about a foot back on new wood; it was und that here the most uniform and most pical leaves of the variety are found. The portance of selecting good specimens and taking the leaves only from this part of w wood must be emphasized. As previous- stated, there are some twenty odd leaf aracters. The stipules or very small leaves the base of the leaf steam or petiole may small or large, they may spread or hold ose to the stem, or they may be almost in- sible. The stem or petiole may be short long in relation to the size of the leaf. may be stout or slender. It may be much nged with red, only slightly tinged with d or entirely green. The leaf itself may thick or thin, may be very hairy on the nder side or quite smooth, free from hairs, nd may be pebbly, with a grained surface the upper side or very smooth. In col- ur it may be dark green, a medium green a light green. In shape it may be oval, rdate (heart-shaped) at the base, nearly und, or much longer than broad. The leaf ay taper more toward the apex or tip, it ay taper toward both the base and tip, may ve distinct shoulders at the base, or may regular and symmetrical. The halves of e leaf may be equal at the base where the em joins or may be uneven at the base. The rrations, or fine markings at the edge of e leaf, may be either fine or coarse, angular rounded, may be irregular and jagged, or gular and even. The margin of the leaf ay or may not be wavy. The leaf might be lded up from the midrib without being wavy at the edges. There are many more characters too, such as the spiral turn of the leaf or of its tip, the amount of reflexing or turning back of the leaf, but these would perhaps be more readily understood if some of the outstanding characters of some of the varieties studied are mentioned.

Varietal Characteristics

Alexander is a large, long leaf with a fairly stout stem, tapering towards the tip, with very coarse rounded serrations.

Bethel is a long leaf, very long for its breadth, with a long, slender stem, fine serrations, is very wavy and tapers both towards base and apex. Its length and waviness are outstanding.

Delicious is a dark green leaf that is folded from the midrib, but is not in the least

DELICIOUS

wavy, has regular serrations and what might be termed "shoulders" at the base of the leaf. It tapers well toward the tip and has a stem of medium length, but the stipules or small leaves at the base of the petiole are inconspicuous. The arrangement of the leaves in Delicious on the twig or branch is unusual in that they are bunched more than other varieties.

Dudley is a large, oval leaf that is folded up from the midrib, its stem is of medium length, the serrations are large but not deep and the leaf is dull not shiny.

Fameuse is an oval leaf with short, stout petiole or stem much tinged with red, prominent stipules. The serrations are regular and rounded. It is a symmetrical leaf.

GOLDEN RUSSET

Golden Russet is a small leaf tapering both toward base and apex, with sharp angular serrations and the tip has a distinct spiral turn. The stem of a Golden Russet leaf is all green, no red on it, and the leaf has a characteristic wrinkling down the midrib, as well as being pebbly and grained on its upper surface.

Lowland Raspberry is a leaf nearly round with a short, stout stem and has coarse, rounded serrations and is shiny. It is quite distinctive in characters and, with Bethel, is among the easier ones to identify.

Melba, which was studied because of its close relationship to McIntosh to determine the differences between one variety and its parent, is a thin leaf, quite flat, with coarse, rounded serrations. It is a larger leaf th McIntosh and more of a perfect oval. It light green in colour.

McINTOSH

McIntosh is a leaf that is folded up fro the midrib, but is never wavy. It has regul but angular serrations, is cordate at the ba and somewhat angular in shape. It is a le that carries its breadth well out towards t tip.

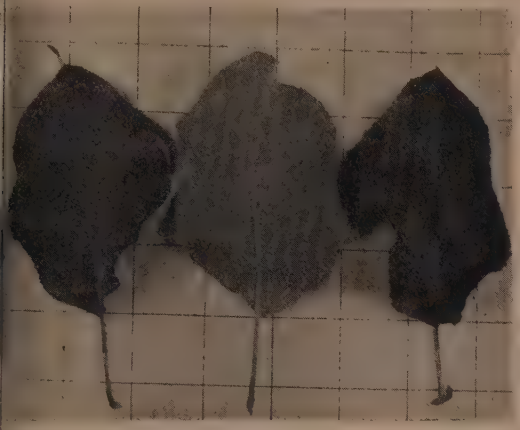
Milwaukee is a small leaf, a dark gre leaf that is very wavy also. The characteri tic spiral turn to the tip is the most pr nounced of any leaves studied. It tape well towards the tip and has a dull surfac

Northern Spy tapers towards the base, a most as much as towards the tip. It has long stem in proportion to the size of t leaf and is narrow in breadth in ratio to i length.

Oldenburg or Duchess is an oval leaf tha is very wavy and quite shiny. It is a larg leaf, but the serrations are fine. It also ha a distinctive veining on the underside that n other leaf displays.

Scott Winter is a small leaf that has irreg ular serrations, moderate size stipules and i an acute leaf tapering well toward the tip It has a long stem in proportion to the lea size and a pronounced tip.

Stayman Winesap is about the same siz as Scott Winter, but is a more regular ova in shape; the stem is shorter and has mor red on it. The serrations, while coarse i some cases, are not as markedly irregular a Scott Winter and it has not as pronounce a taper toward the tip.



WEALTHY

Wealthy is a moderate sized leaf with ong, slender stem and is a leaf that is very vavy. Its tip has a spiral turn, but it is not uite so pronounced as Milwaukee. It is a ong leaf and tapers both towards the base nd the tip.

Wolf River is a large, coarse leaf. It tap- rs toward base and apex and has much oarser serrations than Wealthy. It is a hiny leaf, but is quite thin and has a fairly ong stem.

YELLOW TRANSPARENT

Yellow Transparent is a large thick leaf, vate in shape, with a hairy undersurface. It as a pronounced and distinct tip and shal- ow, regular serrations. Its upper surface has distinctly pebbled or granular appearance.

Results Achieved to Date

Although these differences are quite outstanding, perhaps some of the results achieved by applying the knowledge gained through these and similar studies may provide an even better idea of the value of the work. Once the characters of the various varieties are well fixed the actual time required for identifying trees of a variety is not great. Mixtures can be noticed while walking slowly down the nursery row, and not only can the interlopers be detected but in many cases the identity of the interloping variety can be given.

The Massachusetts Experiment Station has this year certified over 100,000 trees covering thirty varieties. Two concerns in the States are now selling only trees certified true to name.

In applying the work done at the Central Experimental Farm to practical use a small nursery was first inspected. Owing, however, to the small number of varieties grown, to the limited extent of the nursery and the care taken, all stock was found absolutely true, except for crab stock, which in a few cases had been allowed to grow with the stock.

A second and fair sized nursery, growing 15,000 to 20,000 trees annually, was examined. Between 20,000 and 25,000 trees, two and three years old, were carefully gone over. The varieties in the two year old trees were Alexander, McIntosh, Wealthy, Golden Russett, Fameuse, Lowland Raspberry, Melba, Wolf River, Milwaukee, and Yellow Transparent. In the McIntosh twelve to fifteen trees of Wealthy were found and also, in fifteen or more places, twenty to forty trees of Alexander were found. In Alexander, in eight to ten places, anywhere from eight to fifteen trees of McIntosh were found in each place. In Wolf River one tree untrue to name was found. In Milwaukee four McIntosh were located, and in Yellow Transparent two McIntosh were found. The fact that most trees untrue to name were McIntosh or Alexander would suggest that these varieties became exchanged during grafting, that scions were taken from the wrong trees or, what is less likely, that the exchange was made in setting the grafts out.

In the three-year old trees not as many mistakes were found. Fameuse, Lowland Raspberry, Golden Russett, Yellow Transparent, Alexander, Milwaukee and Wealthy were the varieties gone over. Two Yellow Transparent trees were found untrue. In Alexander, McIntosh were found in three places, in Milwaukee McIntosh were found in three places and in Wealthy McIntosh was found in one place; in each instance where a mixture occurred from eight to ten trees and upwards were found. The fact that McIntosh was one of the principal varieties grown at this nursery would account for its frequent occurrence as an interloper in the three-year old varieties.

In every case, except for three trees, identification of the mixed trees was possible and positive identification of these interlopers as McIntosh, Alexander or Wealthy, as the case might be, was made. In the case of this nursery the method proved not only efficient but the total time involved was not a serious factor, since between 20,000 and 25,000 trees were gone over thoroughly in about eight hours, at the same time carefully labelling all mixtures with their actual identity. In the trees gone over the total number untrue to name was very close to 500, which was 2 to 2½ per cent of the total number examined. But, while 2 per cent of trees untrue to name does not seem a high average, if a grower were to have his stock dug from a place wh such mixtures occurred he might readily as many as fifty to a hundred trees wh were untrue to name. Moreover if such i takes were found to occur in a small nurs where the owners were men with a g reputation for honesty and integrity, w shall we expect in the case of larger nurse where much more labour is employed, wh the amount of stock handled yearly is m greater and where the opportunity for r takes to creep in is many times multiplied existing conditions?

The methods which have been indica previously have practically proven their ficiency in the work done thus far, and it mains only for even wider application this work to be made. The number of va ties studied is easily capable of expansion thirty or thirty-five, which would include the varieties more commonly grown, and application of this knowledge can be ma either at the nursery by examination of ma varieties before they leave the nursery, by verifying the identity of young trees j set out in the orchard. Thus far, howev a real beginning has been made and th studies and their application to date wou seem to point the way to the eventual remo of a difficulty which has long been a sou of inconvenience and annoyance to the chardist.

RUSSIAN INFORMATION BUREAU

The lack of continuous contact between scientists, scientific institutions and cultural organizations of the United States and the Union of Soviet Republics has been felt for many years in both countries.

Since the war there has been practically no mutual exchange of scientific publications—with the result that the institutions and organizations concerned were unable to form any comprehensive idea of the mutual activities and achievements.

The Joint Information Bureau in Moscow is in constant communication with most of the scientific and cultural establishments and institutions of the Soviet Union and is in a position to facilitate regular contact as well as an exchange of scientific periodicals and non-periodical publications between the terested institutions, groups and individua of the Soviet Union and the other countri Personal exchange of their works betwe scientists engaged in similar research acti ties could also be arranged as well as t publication of unpublished manuscripts a articles in the general periodical and spec press.

At the request of the Joint Information Bu eau in Moscow the Russian Information Bu eau in Washington has undertaken to rep sent the Moscow Bureau in its endeavo which will no doubt be in the mutual intere of both countries.

The interested institutions, organizatio and individuals may apply to the Russia Information Bureau, 2819 Connecticut Ave N.W., Washington, D.C.

Advanced Registration for Dairy Bulls.*

H. BARTON

Macdonald College, P.Q.

With dairying occupying the position does in this country the matter of dairy attle efficiency assumes a controlling power. Ve have approximately three and three-uarter million milch cows in Canada and neir numbers are increasing. The value of he products manufactured by these cows is ver two hundred million dollars. They aver-ge less than four thousand pounds of milk er year while six thousand pounds is regarded s a minimum for profitable production. Many of these cows would give more milk f they were given better treatment, but many f them would not justify better treatment in rofit returned, and many others now exceed-ng the avetage are failing to do so with conomy. Hence the problem of dairy cat-le improvement is vital.

The material with which we have to work nay be divided into two classes, cattle which re known as purebred and those which are ot. The first class represents the aristocracy, he second represents the masses. One of the hief justifications for the aristocracy is hrough its males as a source of improvement lood for the masses. The aristocracy is livided up into breeds between which there s keen rivalry. Each breed has an organiza-ion to maintain and advance its particular nterests. Some of these organizations have een in existence for fifty years and have onsiderable financial resources, a large pro-ortion of which is expended each year on naintaining a record of registration of their espective populations. Animals may enter his aristocracy only by right of birth, and o animal is refused its birth right except n the ground of age or color. Recently the French Canadian Cattle Association decided o add some restriction to this basis of regis-ration. Among the representatives of these reeds are to be found many distinguished in-ividuals and noted families, and through heir relatives that have had contact with the nasses a great contribution to the improve-nent of commercial dairy cattle has been nade.

Unfortunately, however, as in the case of others, birthright has been the stumbling block of the dairy cattle aristocracy and since in their case utility as well as propagation is imperative for their standing it has been something of a disaster. Inferiority which no artistocracy has been able to eliminate has enjoyed full registration privileges; it has been multiplied and allowed to contaminate increasing numbers of the breed population and what in some respects is even more regrettable it has been deliberately distributed among the best of the masses with the result that deterioration has resulted. This increasing burden of inferiority has retarded the progress of breed development; it has been a source of great financial loss to many people and it has worked untold injury to the cause of cattle improvement.

The plan for Advanced Registration of Dairy Bulls is intended to put purebred cattle on a higher plane by insuring a selected aristocracy based on utility credentials and through which more security may be afforded for the improvement of the masses. It does not challenge birth right but it demands discrimination. It offers official recognition for merit, not limited to a few but available to all who possess it. It should facilitate the sale and distribution of good purebred bulls; it will tend to focus selection on the best breeding sources; it will give added incentive to performance work; it will serve as a standardizing and educational agency; it will reject and eliminate the objectionable and by so doing purify and intensify the desirable, and finally by the isolation of preferential bulls and the extensive propagation of the best it will make for definite progression.

The first section of the chart indicates the part played directly by breed organizations in determining bull standards. It will be

*Paper read before meeting of Macdonald Branch, C.S.T.A., March, 1925.

BULL STANDARDS

- **Breed Organization**
  - Registration
    - Ancestry
    - Color
    - Age
    - Fee
  - Type
  - Size

  → **Bulls Purebred?**

- **Selection**
  - Sex
  - Individual
  - Individual—Dam
  - Individual—Ancestry
  - Progeny
  - Individual—Progeny
  - Record Credentials
  - Individual—Ancestry—Record credentials
  - Individual—Ancestry—Record credentials—progeny.

- **Agencies—**
  - Personal Experience, education
  - Showring—standing, publicity
  - Breed tests—R.O.M. Promotion—information
  - Yearly test—R.O.P.
    - Milk production — Ancestry
    - Fat production — Progeny
  - Public tests—promotion
  - Education—better bull requirements

- **Improvement—**
  - Showring
    - Progeny Judging
      - Prevailing type
      - Uniformity of type.
    - Record Credentials
      - Requirement
      - Rating
  - Advanced Registration
    - Class A—
      - Record dam.
      - Sire at least out of record dam or by qualified sire.
      - Inspection—not under 8 months at time of inspection.
      - Must score 75% under each main division of breed standard of excellence.
      - Inspection of dams or daughters after two years or satisfactory credentials of them.
    - Class AA—
      - Record dam with record 1/3 over requirement for qualification in milk and fat.
      - Sire—qualified or preferential.
      - Inspection—as above.
      - Inspection of dam or daughters or satisfactory credentials of them.
    - Preferential—
      - Progeny
        - Number (to be determined)
        - Milk production
        - Fat production
        - Type
      - Individuality.

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noted that purebred bulls are the result of registration based on ancestry with color, age and fee requirements. Some influence is also exerted on type and size but it is not a registration requirement.

The second section includes a list of separate credentials which at present apply in the selection of purebred bulls for breeding purposes. In the first case nothing but sex enters into it, in others considerations are made as indicated.

The third section shows the agencies that ave been at work in the developing and reg-lating of purebred bull standards.

The last section is the proposed plan for nprovement. It indicates how some of the gencies now operating might be strengthen-d and it provides for three selected classes f bulls. The first to be known as Class A nposes the minimum requirement and is ntended to include satisfactory bulls for ommercial cattle improvement. Class AA xacts a higher standard of parentage and is ntended for the average purebred herd, hile Preferential Bulls are selected on the asis of progeny and will constitute the elite f the breed to which special attention hould be directed. Any bull through time ay be eligible and enrolled in all three lasses. All bulls are to be inspected for ype in accordance with the standard of ex-ellence of the breed to which they belong nd it is proposed that each bull be requir-d to score at least 75% in each main divi-ion of the standard in order that no bull ith a single important defect may be ac-epted. A minimum age of eight months or inspection is suggested. It would appear hat a higher age minimum would be esirable for some breeds but since it is im-ortant to make the plan workable for all reeds, facilitate sale, etc., and since in any ase there will be some latitude with a se-ond inspection necessary as well as the in-spection of all dams at a later date eight months was decided upon. To some the problem of inspection seems insurmountable but against this opinion it may be argued that recently one association president pro-posed inspection of all animals for registra-tion in his breed; this inspection will not involve the fine discrimination now practis-ed with even junior calves in our show rings; inspection and grading of horses, sheep, and cattle is now being done successfully in Can-ada, and in other countries it is practised with at least two important breeds of cattle for all registration and from one of which we are annually making importations for cattle improvement here.

A fee must accompany application for in-spection.

All the Dairy cattle breed associations have accepted the plan. The Holstein-Friesian Association has decided that for their breed, Record of Merit credentials should be given the same recognition as those of Record of Performance and this presents a difficulty that will have to be dealt with if all breeds are to go forward in a joint effort on a common plan.

The Dominion Government authorities have endorsed the plan and are prepared to support it.

Bovine Tuberculosis Research.*

When Robert Koch discovered tuberculin in 1890 he thought he had a cure for tuberculosis, but after further investigation he found it had no curative properties, but was a valuable agent for the diagnosis of this disease.

Ever since the discovery of tuberculin scientists all over the world have been persistently engaged in tuberculosis research. Their objective has varied in accordance with the prevalence, or otherwise, of this disease in their respective countries.

In Europe bovine tuberculosis has for many years been too common to enforce eradication measures, and their scientists have consequently been conducting their research with a view to obtaining an immunizing agent as their only hope of overcoming the disease.

In Canada and the United States, where the average percentage of tuberculosis in cattle does not exceed 10 and 15 per cent respectively, it is feasible and practicable to eradicate this disease and to maintain our herds free from it, provided the stock owner is willing and prepared to cooperate, and bear a share of the loss. Policies are, therefore, available to stockmen in both these countries, and the only deterrent is that of finance.

In the United States the municipalities, counties and individual States are cooperating with the Federal authorities both financially and in the field, and this work is progressing rapidly. It has already reached such proportions that there is no possibility of it being abandoned, or delayed, through reports of new discoveries. If Canada desires to take advantage of this market at any time it may be considered a profitable one, we must have a large number of tuberculosis-free cattle, and we cannot, therefore, afford to relax our control measures.

Experience has shown that, unlike in the countries of Europe, this disease can be eradicated on this continent without interfering with the live stock situation. Much of our research work has consequently, and quite properly been directed toward improving tuberculin, the best known diagnostic agent, also to the comparative study of the different types of tuberculous infection w which human beings, cattle, buffalo, swi poultry and other animals become infected, the relationship between these different typ and of the possible transformation of type to another.

Another line of research undertaken aims determine the relationship and the factors t intervene between infection, resistance a active tuberculous disease. When the nat of the tuberculin reaction itself and the m ner in which animals react to tuberculin the different stages of infection has been f ther investigated and studied, there is j the possibility of some means being disc ered to differentiate between animals so s iously affected as to be dangerous, and th so slightly affected as to permit of their be kept for breeding or other purposes. vestigations along this line have been goi on with a herd of tuberculous cattle that H been maintained at our research station f five years.

A valuable and entirely new method for t standardization of tuberculin has been veloped at our Research Station, Hull, P. This new method enables the Department manufacture tuberculin of a definite kno strength. This, as will be admitted, H many advantages.

While undertaking research to impro methods particularly fitted to existing co ditions in this country, the Department h at the same time kept constantly in tou with the progress being made in other cou tries in their special lines of research. A vantage has always been promptly taken any accepted discovery, but until discover have been confirmed by authoritative scien fic bodies their application has been limit to investigations of our own animals in o own research stations.

Tuberculosis, in man or in animals, is u doubtedly the biggest single economic fact that has to be dealt with from the standpoi of health. It is a universal question whi several generations of workers have been e deavouring to solve. During the past for

*Prepared by the Health of Animals Brand Dominion Department of Agriculture.

ars or more, since the discovery of the icillus of Koch, there have appeared at in-rvals many "discoveries" or "new cures" r tuberculosis and of serums and vaccines hich were to afford protection or confer an mmunity to the disease. Great hopes have en raised by such discoveries again and gain, only to be dashed to the ground. It is ue that discoveries have been made and are ing made from year to year by scientists ho are devoting their lives to this problem, hich materially advance knowledge of tuber-losis and which slowly but surely are lead-g to the Mecca of our hopes. Some mis-ken conclusions have been made by the ientists themselves, even by the great mas-r, Robert Koch; but the true scientist has ways announced his discovery of new facts d phenomena relating to tuberculosis with-t pretentious claims and asks as a rule, ly that his work and methods be given fair vestigation and trial under properly con-olled experimental conditions.

When such announcements, however, find eir way into the lay press they are most equently so altered and exaggerated, and ch extravagant claims added to them by ir-sponsible persons that the general public greatly misled, and, in due time, suffers sillusion and disappointment.

Lately there have appeared many notices, th in the scientific and in the lay press in gard to the prevention of tuberculosis by eans of vaccination, and especially in con-ction with the experiments made by Pro-ssor Calmette and his associates in France.

Professor Calmette by his noteworthy hievements in Tuberculosis Research has a ry high reputation and without doubt his thod of anti-tuberculosis vaccination de-rves close attention and scrutiny. It must cessarily be submitted to the most thorough al upon large numbers of animals under rfectly controlled conditions, and in the nds of different and reputable investigators. t until this has been done will it be pos-le to pronounce upon the safety and ef-iency of this method of vaccination, and ive at its proper valuation.

Our research men have been keeping in se touch with Calmette's work and receiv-a culture of his vaccinating material in Ottawa late last fall. Experiments were commenced as soon as new cultures were grown with a view to investigating the claims made for the vaccine. These experiments dealing as they do with a relatively untried organism, are naturally being limited to our own animals in our research station, and in order to extend this work an additional building is nearing completion.

As this work extends it will be necessary of course to materially increase our facilities in order to give our research workers every opportunity to make the widest and most thorough investigations with the least possible delay, under the most favourable conditions.

The greatest care is being exercised, even in France, to limit these investigations to experimental animals only, and no country has been reckless enough to attempt to apply this treatment in a general way. In view of the very nature of bovine tuberculosis it will take years of patient intelligent endeavour before scientific bodies will be in a position to accept or disprove the claims made for this vaccine.

It should not be forgotten that this disease has baffled scientists for generations, and that in their immunizing experiments they have been confronted with unusual difficulties in that this disease differs under ordinary conditions from other infectious diseases, as it has not the tendency to confer an immunity in an animal in which it produces lesions, that is changes in the structure of some body tissue.

Dr. Calmette was engaged in this work for more than twenty years, and about a year ago he announced that he had been able to confer on young and *non infected* animals a true immunity against either natural or artificial infection. In order to obtain an organism that could survive when injected into a healthy animal and still be incapable of causing tuberculous disease, he had to grow and maintain two hundred and thirty (230) successive cultures of the organism over a period of thirteen years. He claims that this vaccine will protect an animal for a period of from one year to eighteen months, but it is safe to use it only upon animals entirely free from tuberculosis.

Although it is claimed that this vaccine cannot infect a healthy animal, it causes a marked extension of the disease when injected into a tuberculous one.

The claims for this vaccine by the discoverer are extraordinary, and had they not been made by a universally acknowledged scientist, little notice would have been taken of them. They are as follows:

1. It contains the living organism, capable of multiplying in the animal body.

2. It cannot produce tuberculosis in a healthy animal, in spite of its being able to multiply in the body.

3. It produces a marked extension of the disease if injected into a tuberculous animal.

4. Healthy animals inoculated with this vaccine react to the tuberculin test.

As there is always a possibility that a live organism, whose virulency has been attenuated by growth in artificial media, may recover its original virulency and produce disease in a virulent form in vaccinated animals, it is imperative, in our live stock interests, to exercise the greatest caution, as only time and unlimited experiments in immunization can prove beyond doubt that this will not occur.

It would be the height of folly to rush blindly and apply an insufficiently tested discovery indiscriminately in a country in which the disease exists to a limited extent. Even though time may prove the correctness of claims, it cannot be applied to infected mals, and in view of the existing condit in this country our live stock interests w still be better served by an eradication po with immunization of our young and infected animals as a most important when local investigation by our federal search workers, time and scientific bodies in a position to confirm these claims.

We should not overlook the fact that vaccine is only in the experimental state that it has not been put to a general test should we forget the possibilities of o discoveries and claims of a somewhat sim nature that are being made by others f time to time.

Usually discoveries of a scientific nat take years to confirm, therefore it would appear wise to condemn, approve or ad hastily. It is gratifying, however, to ref that with scores of pathological laborator including our own, scattered all over world, all concentrating their activities u the discovery of a vaccine that will pr completely and permanently effective in munizing against tuberculosis under all cumstances, success should soon be wit sight.

In any event, and in conclusion, while t great problem of discovering a success immunizing serum or agency is being work out, the obvious course for Canadians to p sue, is to continue our present T.B. eradi tion methods until something better is fou

C. S. T. A. Forum

This section has been introduced in *Scientific Agriculture* in order to publish communication from C.S.T.A. members dealing with matters of professional interest, and also for the publication of subsequent discussion of such matters. It is hoped that members will take full advantage of the opportunity thus offered of bringing their views to the attention of the profession, and in this way promoting interesting and helpful discussion. The names of correspondents will be omitted if desired, but must always be furnished to the General Secretary.

Unless this section of the magazine is supported by the members, it will have to be abandoned at once. Please address all communications to the General Secretary, C.S.T.A., Ottawa, Ont.

MORE ABOUT DUPLICATION

Under the heading "Duplication", a correspondent in the February issue of *Scientific griculture* raised the important question of uplication between different branches, deartments and divisions engaged in agricultural work. This article was itself a duplicaon of what has often been stated, frequent-, in much more forceful terms, of a sitation that has long called loudly for reform. contained, however, a constructive suggeson that is well worthy of the consideration technical agriculturists. Now we have, the March issue, a thoughtful article from e pen of the Dominion Live Stock Comissioner, that will well repay the earnest udy of all of us.

A foreign expert who lately made a study our Departments of Agriculture is said to ve asked the question whether the present ndition existing in Canada was the creation mad men. He saw experimental farms, me under provincial and some under fedal direction, sometimes a few miles from ch other, with no common policy, no logil division of work, no co-operation, no conltation in regard to policy, no or little owledge one of the other. He saw Agriltural Colleges engaged in educational ork in different provinces, while "Illustran Stations" scattered here and there over e landscape attempted to exemplify certain ethods of culture often at variance in cern important particulars with that taught by the colleges. At any rate little correlation or co-operation was evident between these two important educational agencies. He saw "promoters" of different sorts doing work under federal control, carrying on the same kind of work that county agents or district representatives perform under provincial auspices. One set of promoters "promoted swine, another "promoted" cows, while still another tested the same cows after they had been promoted. "Why", said he, "this divorce between the dairy cow and the bacon hog?" "Why all this organization?" he wished to know, "cannot one set of men do all these things, instead of having several men and several organizations competing for the same men, boys and cows?" When told these different officials avoided the same communities, he only considered that this aggravated the case, since logically these things would go together and should be handled by one organization, call it a Junior Agricultural Society or what you will.

It was the sight of all these things and many others of a similar nature that gave rise to the orginal query of this foreign expert. Of course the implication contained in it is entirely unfair to the creators of our Departments of Agriculture. At the beginning there was no clear line of demarcation laid down delimiting the spheres of influence of different departments or even branches of the same department. Furthermore, departmen-

tal heads, realizing that their prestige is judged entirely by the amount of money they spend and the number of men they have under them and being only human—sometimes very, very human—have no incentive to do other than they do. The result is that conditions do not always come about by design; they "just grow" until the orginal creators would scarcely recognize the monstrosity into which the original creation has developed. However, if our foreign student had been a biologist instead of an economist he would have realized that the law of evolution is of universal application. We must, however, realize, with him, the grave dangers of the present vicious trend being permitted to continue unchecked, until we have a promoter for every species of farm animal and plant and an expert for every phase of animal and plant culture. Suppose the possibilities of this situation should dawn upon the intelligence of the entomologists, bacteriologists, mycologists. The thing is likely to evolve by a kind of departmental orthogenesis, until we have an inspector, promoter or dry nurse, as the case may be, not only for each zoological species of farm animal but for each bug, bacterium and blight! We are told that the crust of the earth is embedded with the remains of organisms that have perished because they became too specialized to meet changing conditions. May this not, then, be the doom of Departments of Agriculture?

By all means appoint a commission if it is to be composed of men of modern ideas and open minds and is not made the refuge of the superannuated or the reactionaries. Everyone capable of rational thought realizes fully what is needed. Everyone with practical ideas of the matter admits that a few specialized workers working through many district agents, is the ideal system. Unquestionably Dr. James had the right i for bringing the different agencies toge in their proper relation and if we only a commission composed of men with his ion, patience and tact the problem would on a fair way to solution. On the wh however, Mr. Arkell's idea of a carpe seems a better one under the circumstan Give him hammer and saw, mallet and ch and add thereto a few sticks of dynamite assorted sizes and a few bottles of chl form, even though these are not the work tools of his trade. Above all clothe him w authority and do not stay his hand ever some one's feelings are hurt.

The ideal time to set our commission our carpenter, or both, to work would h been when the Agricultural Instruction was first considered. Our commission co have found out what was needed and the c cive force of the money power could have tained the consent of all the parties concer for our carpenter to erect the structure wh they designed. That time is passed, bu similar and better conceived scheme can be formulated. No more of the peop money is needed, only ideas and goodw added to a little force properly applied.

No class of people respond more rea to properly directed effort on their bel than the rural population, but all who in touch with actual conditions are aware the growing resentment felt among farm at the waste involved by this duplication, t is only too apparent to them. This very r resentment is doing much to frustrate good work of many enthusiastic and comp ent officers, who, in spite of an antiqua and inefficient system and in spite of couragement and seeming indifference on part of their superiors, are carrying on spl did work in all sections of the Dominion.

(Reference No. 102)

Concerning the C.S.T.A.

NOTES

R. R. Hurst (O.A.C. 1922) has been transrred from the Dominion Laboratory of ant Pathology at Saskatoon to the laborary at Charlottetown, P.E.I., as Assistant ant Pathologist. His address is P.O. Box 4, Charlottetown.

D. B. Shutt, (O.A.C. 1922) who has been ting Professor of Bacteriology at the Manioba Agricultural College since 1922, is takg post graduate work in Bacteriology at the ichigan Agricultural College, East Lansing, ich.

R. J. Skelton, (O.A.C. 1916) formerly Exsion Assistant in the Poultry Husbandry epartment of the University of B.C., has en appointed Manager of the Salmon Arm reamery Association at Salmon Arm, B.C.

C. M. Dickey, (O.A.C. 1920) has been ansferred by the S.S.B., from Truro, N.S., Kentville, N.S., as Field Supervisor.

G. A. Scott, (O.A.C. 1923) has been apinted Assistant Plant Pathologist under the ominion Botanical Division with headquarrs at the University of Saskatchewan. Mr. ott completed his Master's course at Macnald College in 1924 and was taking work wards his Doctor's degree at the same intution when he accepted the above appointent.

R. W. Donaldson (O.A.C. 1915) has regned from the staff of the S. S. B. at St. hn, N.B., and is now engaged in extension ork under the Massachusetts Agricultural llege, with headquarters at Waltham, Mass.

Luc Duval (Laval 1922) has been apinted Assistant 'Agronome' for Wolfe unty, P.Q. His address is D'Israeli.

MACDONALD COLLEGE RESOLUTIONS

The two following resolutions were passed at the annual meeting of the Macdonald College Local held on March 19th, and 20th:

1. Resolved that this meeting approves of the suggestion that Federal and Provincial Departments of Agriculture and the various Agricultural Colleges and Experimental Farms use *Scientific Agriculture* as a regular medium for the publication of such results as may be deemed to be of general technical interest, and especially that the heads of departments in all of these bodies should use *Scientific Agriculture* as a means of making known the introduction of new projects and the progress being made in established projects. This meeting considers such a proposal particularly opportune in view of the fact that the publication of *The Agricultural Gazette* has been discontinued. It is hoped, therefore, that the Editorial Board of *Scientific Agriculture* will take steps to bring the matter to the attention of the various bodies concerned.

2. Resolved that this meeting heartily endorses the proposal which has been brought forward to the effect that the pension of Dr. Charles E. Saunders be increased to $5000 per year in view of his unique and extraordinary contributions to Canadian Agriculture, and that the General Secretary be asked to send a copy of this resolution to the Minister of Agriculture and to the Member of Parliament sponsoring the bill.

BRITISH COLUMBIA LOCAL

The annual meeting of this Local was held at the Court House Chambers, Vancouver, on March 19th and 20th. Details of the meeting have not yet been received but a copy of the programme shows that the Executive Com-

mittee presented to the members a very interesting series of lectures as well as several important business sessions.

It is expected that a number of the papers will be available for publication in an early issue of *Scientific Agriculture*.

FIFTH ANNUAL CONVENTION

During the past few weeks the Executive of the Alberta Local has been taking active steps to ensure the success of the Annual Convention which is to be held at the University of Alberta from June 24th to June 26th. The following committees have already been appointed and will remain in charge of arrangements until the close of the convention:

Entertainment Committee: J. Macgregor Smith, Chairman; S. G. Carlyle, D. H. Galbraith.

Programme Committee: J. P. Sackville, Chairman; F. W. Wyatt, P. R. Talbot.

Reception Committee: F. H. Reed, Chairman; L. T. Chapman, G. M. Stewart, E. C. Hallman.

It is hoped that it may be possible to announce a fairly complete programme in the next issue of the magazine, but in the meantime, those members who are planning to go to Edmonton from distant points are asked to secure their railway tickets to Edmonton, via Calgary, because of the fact that a motor trip is being arranged from Calgary to the Prince of Wales' ranch on Saturday, June 27th, and the same evening from Calgary to Banff for the week end.

CIVIL SERVICE VACANCY

The Civil Service Commission is advertising the position of Assistant Entomologist for the Division of Forest Insects of the Dominion Entomological Branch at an initial sal of $1920 per annum, with increases at rate of $120 per annum to a maximum $2280.

Applications for this position must re the Civil Service Commission, Ottawa, later than April 9th and application fo may be obtained from the Postmasters Prince Rupert, Victoria, Vancouver, Que Fredericton, St. John, Charlottetown, Halifax or from the Civil Service Comm sion.

ARTICLES

Members of the Society are not giving p per support to the official organ in the way contributed articles. There are a good m members who are doing work of an extren interesting and important character and v fail to keep other professional workers formed as to the results which they acco lish.

There appears to be a mistaken idea t articles for *Scientific Agriculture* sho deal almost exclusively with research or ot technical phases of the subject. The fact t the magazine has, in the past, featured t type of article is simply because resea workers and experimentalists have constitu the majority of our contributors. At the sa time a study of C.S.T.A. membership reveals the fact that at least seventy-five cent of the members are engaged in agric tural administration and extension and c sequently are more interested in a fai practical type of article.

At the present time the General Secret is finding it extremely difficult to secur sufficient number of suitable articles to ma tain the magazine in its present form size and any members who are in a posit to contribute to the magazine are asked submit manuscripts to the General Secret on or before April 15th, for publication the May or June issues.

The Inheritance of Resistance to *Puccinia Graminis* in Crosses Between Varieties of Durum Wheat.[1]

J. B. HARRINGTON

Assistant Professor of Field Husbandry, University of Saskatchewan, Saskatoon, formerly Graduate Student in Plant Breeding, University of Minnesota.[2]

INTRODUCTION

During the past few years the problem of breeding high quality common spring wheats resistant to stem rust (*Puccinia graminis tritici* Erikss. and Henn.) has been attacked from various angles and by a number of workers. The desirability of having rust-resistant varieties of wheat has been recognized for many years but accomplishment in the line of breeding has been slow. Frequently a variety or hybrid appeared resistant one year but susceptible in later tests. The studies of Stakman and others (16, 17 and 18)[3] have given logical explanation of these results. The knowledge that there are several physiologic forms of *P. graminis tritici* has helped to formulate a definite mode of attack on the problem. While it is true that certain economic varieties of wheat are resistant to many of these physiologic forms, it is desirable to produce varieties which will be resistant to all of them. To attain this end, an extensive knowledge of the genetic factors concerned with rust reaction and of their linkage relationships is essential.

Probably the first important work on the inheritance of rust resistance in wheat was reported by Biffen in 1905, 1907 and 1912 (4, 5 and 6). He crossed Red King, a variety of *T. vulgare*, susceptible to *Puccinia dumarum* (Sch.) Erikss. and Henn., with Yvet, an immune variety. He obtained a 3:1 ratio of susceptible and immune plants in F_2, and found immunity to be independent of any discernible morphological character. Later, Biffen (7) reported the production of rust-resistant wheat that likewise possessed other desirable economic characters. Nilsson-Ehle, in 1908 and 1911 (13 and 14), also studied the inheritance of resistance to stripe rust. Unlike Biffen, he obtained transgressive segregation and various types intermediate between the parents in F_2. Segregation was explained on the basis of multiple factors. In 1922, Armstrong (3) repeated Biffen's work on a larger scale and obtained results similar to his.

Since 1917, a number of workers have investigated the inheritance of resistance to black stem rust. Waldron (20), in 1921, was unable to explain results he obtained in the nursery in a cross between Kubanka and Power Fife on the basis of a single factor for resistance. Puttick (15) published in the same year the results of his study of the reaction of the F_2 generation of a cross between a common and a durum wheat to two physiologic forms of rust to which these varieties reacted reciprocally. All gradations between complete susceptibility to and immunity from both forms of rust were obtained. In 1918 Melchers and Parker (12) found that a single factor was responsible for the resistance to a single form of rust in crosses between Kanred, a winter wheat, and Marquis and other spring varieties. Aamodt (1 and 2) in 1922, studied the inheritance of resistance to several physiologic forms of stem rust in a cross between Kanred and Marquis. Kanred is resistant to a number of forms to which Mar-

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1 A thesis submitted to the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Published with the approval of the Director as Paper No. 484 of the Journal Series, Minnesota Station.

2 The writer desires to express his appreciation especially to Dr. H. K. Hayes (University of Minnesota), under whose direction the study was made, and to Dr. E. C. Stakman (University of Minnesota and U. S. Department of Agriculture) for valuable suggestions concerning the pathological phases of the work; he wishes to thank Messrs. M. N. Levine and O. S. Aamodt (both of the U. S. Department of Agriculture) and various others for their assistance and active interest in the investigation.

3 Reference is made by number to literature cited.

quis is susceptible. Families, homozygous for spring habit of growth and for resistance to all the forms of rust to which Kanred is resistant, were obtained in the F_3 generation. A single factor apparently determined the reaction to several physiologic forms.

Some investigators have used wheat species of different chromosome number in breeding for rust resistance. In 1920, Hayes, Parker, and Kurtzweil (10) found resistance dominant in crosses between varieties of *T. vulgare* and *T. dicoccum*. In crosses between *T. vulgare* and *T. durum*, susceptibility was dominant and there were strong linkages between rust resistance and durum character. However, some hybrids of vulgare type possessed most of the rust resistance of the durum parent.

According to Hayes and Stakman (11), twenty-one of the thirty-seven known physiologic forms of stem rust have been found in the area where hard red spring wheats are grown. Recent studies in breeding for stem rust resistance at the Minnesota station[4] show the possibility of synthetically producing a desirable vulgare variety of wheat that will be resistant to all of these physiologic forms. It is hoped to accomplish this by means of several crosses and double crosses between varieties having the desired resistance and those having the necessary bread-wheat qualities. Considerable progress has been made in the investigation. Some of the Kanred-Marquis hybrids possess the desirable yielding, milling and baking qualities of Marquis in addition to the resistance of Kanred and spring habit of growth. Some of the hybrids obtained from crossing Marquis with Iumillo, a very resistant durum variety, are highly resistant under field conditions. They also have good yielding ability and closely approach Marquis in milling and baking quality.

Hayes and Aamodt (9), in 1923, reported the results of a study of rust resistance in a cross between Kota and Marquis. Kota (21) is the only common wheat of the Northwestern spring-wheat area that is rust resistant, except for recently produced hybrid sorts, but it lacks in yield and has weak straw under humid conditions. The reactions of the hybrids were tested to physiologic forms 19 and 27 in the green house. The results tained with form 19 could not be explai on the basis of a single genetic factor. K was immune from form 27 in the greenho and Marquis was resistant. Among the families, were some that reacted like parental varieties and others that w homozygous for susceptibility. The res were explained on the basis of two indep dently inherited factors for immunity and sistance contained in the Kota and Marq parents, respectively, each factor being al omorphic and dominant to a factor for s ceptibility. The reaction of F_3 families forms 19 and 27 in the greenhouse was c related with the behavior of these famil under field conditions. It was conclu that the greenhouse reactions were not sa factory as a means of isolating F_3 lines wh would have the Kota type of resistance in field.

Owing to the fact that the resistance of d um wheat varieties had not been investiga very extensively, the chief purpose of the search herein reported was to study the heritance of rust resistance in durum cros with a view to learning more about the nu ber, location, and nature of the genetic f tors involved.

MATERIALS AND METHODS

Hybrid families[5] of two *T. durum* cross Kubanka No. 8 (C.I.4063)[6] x Pentad (C 3322) and Mindum (Minn. No. 470) x Pent were used. Kubanka No. 8 is a white-seed selection from common Kubanka (C.C.144 Pentad is a red-seeded variety selected at North Dakota station. Mindum is a wh seeded selection of the Arnautka type. M dum and Kubanka No. 8 were used beca they excel in yield and other desirable qua ties; however, these varieties are somew susceptible to rust under Minnesota con tions. Pentad was selected because of high resistance to rust. This variety is

[4] Unpublished results of the Minnesota station.

[5] The term "family" is used in this article denote the seedling plants grown from the se of a single parent plant whether it was a hyb or a variety control culture. In 1922 the par control cultures were not each the progeny o single parent plant.

[6] U. S. Department of Agriculture "Cereal vestigations" number.

sirable in macaroni quality, slightly low yield and is unpopular with millers because of the redness of the kernel. It was oped that the investigation would lead to the oduction of a durum variety possessing the st resistance of Pentad together with the ed color and other desirable qualities of indum or Kubanka No. 8.

The crosses were made in 1920 and the F_1 eneration was grown in the greenhouse at ashington, D.C., during the winter of 1920-1. The F_2, F_3 and F_4 generations[7] were own in the plant-breeding nursery at Uniersity Farm, St. Paul, Minnesota, during the asons of 1921, 1922 and 1923, respectively. he plants were harvested individually. The hysiologic forms of rust were among those eing studied by Stakman and Levine.

A full description of the 1922 greenhouse chnic, the differential varieties, and the orms of rust used are given in an earlier aper by the writer and Aamodt (8). Plants f each F_3 family were grown in 1922 in sixch pots in the greenhouse, one family in ach pot. Control families of each of the parntal varieties were handled in the same manr. Plantings of F_4 and F_5 families in 1923 nd 1924, respectively, were made at two difrent periods, except in the case of the F_4 eneration of Kubanka No. 8 x Pentad, where ree replications were made. Hand inoculaon was used in 1922 and 1923. In 1924, nly one physiologic form of rust was used nd brush inoculation[8] was found to be very atisfactory. Data on the character of infecon were taken when the development of redinia and of necrosis on the leaf had eached full expression. This occurred in 5 to 22 days after the date of inoculation epending upon the light, temperature, and other environmental conditions. The conditions for each planting throughout the early growth of seedlings, inoculation, incubation, and period of rust development were kept as nearly uniform as possible. The proportion of infected plants obtained was high, averaging about 95 per cent.

Four physiologic forms of rust, 1, 17, 21, and 34, of established constancy (in so far as consistent reaction on seedling plants of 12 differential varieties of wheat was concerned) were employed. Form 17 was used for preliminary work with the cross Mindum x Pentad in the fall of 1921. At that time it was the only form available to which Mindum was susceptible and Pentad more or less resistant. Work with this form was not very satisfactory because the Pentad reaction was quite variable and overlapped considerably the range of Mindum. It was desired to use two forms to which Mindum and Pentad would react reciprocally. Mindum was found to be practically immune from form 1, whereas Pentad was intermediately susceptible. Early in 1922, form 34, a recently acquired one, proved far superior to form 17 for this study, consequently the latter was dropped. Mindum is susceptible to form 34 and Pentad is resistant. For the Kubanka No. 8 x Pentad cross, no two forms of rust were available to which the parent varieties reacted reciprocally. In fact, form 34 was the only one with which the reaction was sufficiently different to warrant a genetic study of these varieties. Kubanka No. 8 is intermediate in reaction to form 34 with an extremely wide range in type of infection. In 1924, form 21, which resembles form 34 in its effects on Mindum and Pentad, was used in order to discover whether or not the genetic conditions responsible for resistance to these forms are identical.

The symbols employed and herein described indicate the types of infection produced on the wheat seedlings in the greenhouse by the different physiologic forms of stem rust. They are identical with those adopted by Stakman and Levine (1922). It will be seen that these symbols form a series from 0 to 4+ and indicate types of infection running from immunity through to extreme susceptibility.

[7] The material was a part of that used for the urpose of obtaining resistant wheat for growing the Northwest, a problem which was being coperatively investigated by the Sections of Plant reeding and Plant Pathology of the Minnesota gricultural Experiment Station, and the Office f Cereal Investigations of the U. S. Department f Agriculture.

[8] Pots of plants, that were heavily infected with ust, were held partly inverted and brushed lightly ack and forth over a number of pots containing he seedlings to be inoculated. These seedlings aving been moistened previously, received a fair even distribution of spores.

0. No uredinia developed but definite hypersensitive areas present.

1. Uredinia minute and isolated; surrounded by sharply defined, continuous, hypersensitive areas; hypersensitive areas which lack uredinia may also be present.

X–. Uredinia variable; apparently includes on the same leaf blade various combinations of types 0 or 1 with types 2 or 3–, or all of these types.

2. Uredinia isolated and small to mid-sized; hypersensitiveness present in the form of necrotic areas in circles; uredinia often surrounded by green islands.

3–. Uredinia very small and isolated; development of rust subnormal; chlorotic areas usually present; true hypersensitiveness absent.

X. Uredinia very variable; apparently includes on the same leaf blade combinations of one or more of the 0, 1 and 2 types of infection with either or both of types 3 and 4–; type 3– may also be present.

3. Uredinia small to mid-sized; coalescence infrequent; development of rust somewhat subnormal; true hypersensitiveness absent; chlorotic areas, however, may be present.

X+. Uredinia very variable; apparently includes combinations of one or more of the types 0, 1, 2, and 3– with type 4 on the same leaf blade; types 3–, 3 and 4– may also be present.

4–. Uredinia mid-sized; frequently coalesced, true hypersensitiveness absent; chlorotic areas or borders surrounding uredinia frequently present.

4. Uredinia large or varying from mid-sized to large, usually numerous and confluent; true hypersensitiveness absent; chlorosis seldom present.

4+. Uredinia large and markedly confluent; hypersensitiveness and chlorosis absent.

GREENHOUSE INVESTIGATIONS

Physiologic Form 17.

A preliminary investigation was made in the fall of 1921 to determine the nature and extent of the variations in types of infection produced by form 17. Seed of 12 varieties and 32 Mindum x Pentad F_3 families was planted in November and a duplicate series planted in December. A total of 1454 lings were inoculated. It was concluded where fairly uniform treatment was acc the plants, environmental influences wer sufficiently strong to interfere seriously the interpretation of the results.

In February, 1922, a series of 17 families with a total of 2168 plants o cross Mindum x Pentad were inoculated form 17. Mindum is susceptible to this and Pentad is partially resistant. Owi the fact that the range of infection type the parental varieties overlapped cons ably, the hybrids were difficult to cla Since no further work was done with 17 the detailed data are omitted here. S two of the 174 F_3 families appeared t as susceptible as Mindum. This was indication of the presence of a single genetic factor governing the reaction to form of rust.

Results of Inoculating F_4 Seedlings of Cross Kubanka No. 8 x Pentad wi Physiologic Form 34.

In 1923, all plantings of Kubanka N x Pentad material were replicated three t at different periods giving four complete ies of results. In each series, an F_4 fa was represented by 6 to 18 plants givi total of 25 to 50 plants per family that inoculated. The number of hybrid fam and parental-variety families in a series too large too allow them all to be inocul simultaneously, for the capacity of the inc tor was about 100 pots. Therefore, a of the families of a given series were inc ed at one time and the remainder two later. The correlations between the re for the different series yielded r values r ing from 0.341 ± 0.053 to $0.533 \pm 0.$ As all of the values of r were sufficiently to denote correlations of practical importa the results for each family were comb for the purpose of genetical study.

The object in replicating the plant three times at different periods was to certain the extent to which replication creased the reliability of the results. It veloped that a single sowing of seed f each hybrid family was as accurate as eral sowings, excepting in so far as tem ary, unfavorable environmental condit

affected the development of rust on all seedlings of one planting without influencing to the same degree the rust development of seedlings incubated at an earlier or later period. In view of this fact and because for a genetic study, it is desirable to use a much larger number of seedlings of each family than can be grown conveniently in a single six-inch pot, it seemed desirable to use for each family two plantings made at different periods.

A total of 15 white-seeded F_3 lines comprising 134 F_4 families and 5,092 F_4 seedlings were tested. In addition, 14 families of each parental variety were used. Pentad is partially resistant and Kubanka No. 8 is slightly susceptible to form 34. The results are presented in Table I.

TABLE I—Distribution of the F_4 seedlings of the cross between Kubanka No. 8 and Pentad according to the types of infection caused by physiologic form 34.

Classes of parental F_3 lines	Classes of F_4 families and parental varieties	Plants not infected	Distribution of F_4 plants according to the types of infection shown										Number of plants	Number of F_4 families
			0	1	X–	2	3–	X	3	X+	4–	4		
IR	F_4 families R		2	6	18		1	8		2			37	1
"	" " IR	7	18	27	89	4	4	46	17	40	82	3	337	8
		7	20	33	107	4	5	54	17	42	82	3	374	9
HR	" " IR	6			5	7		14	23	8	18	3	84	2
"	" " HR	1		2	31	5	4	18	34	38	53	19	205	6
		7		2	36	12	4	32	57	46	71	22	289	8
H	" " R	1	1	8	25		5	22	4	3	3		72	2
"	" " IR	13	9	40	94	8	3	37	50	29	98	8	389	10
"	" " HR	47	21	35	136	33	14	92	105	153	295	108	1039	28
"	" " H	22	7	32	115	19	10	79	77	191	333	230	1215	33
"	" " HS	6	2	4	25			16	18	46	242	204	563	14
"	" " IS	9						1	3	20	123	152	308	8
"	" " S	4			2					10	15	105	136	4
		102	40	119	397	60	32	247	257	452	1109	907	3722	99
IS	" " H							1	5	1	14	6	27	1
"	" " HS								3		17	18	38	1
"	" " IS	6			3			2	6	24	107	174	322	8
"	" " S	4									28	249	281	8
		10			3			3	14	25	166	447	668	18
	Kub. No. 8 IR		1	1	10			7	1	1	5		26	1
	" " HR	2	6	10	10			6	6	17	33	6	96	3
	" " H	1	3	1	13		5	16	7	41	74	38	199	6
	" " HS							2		8	18	10	38	1
	" " IS									7	13	11	31	1
	" " S	1								3	1	33	38	2
		4	10	12	33		5	31	14	77	144	98	428	14
	Pentad R	4	16	48	129	4	8	55	22	1	14	1	302	8
	" IR	6	23	20	59	10		28	28	29	32	2	237	6
		10	39	68	188	14	8	83	50	30	46	3	539	14

In order to interpret the results, it was first necessary to determine, on the basis of the reactions of the parental varieties, what the significance of the different types of infection was in terms of resistance and susceptibility. The range of Kukanka No. 8 extended from 0 to 4. Consequently, it was not suitable as a basis for hybrid classification. The range of Mindum, a susceptible variety, was from X+ to 4, whereas Pentad showed a range from 0 to 4–. The ranges of Mindum and Pentad overlap at the X+ and 4– types and it is reasonable to suppose that these types indicate a condition intermediate between resistance and susceptibility. Therefore, seedlings with types 0 to 3 were considered resistant, those with types X+ and 4– as intermediates, and those having type 4 infections as susceptible.

On the basis of the relative proportion of seedlings showing resistant, intermediate, and susceptible types of infection the hybrid and parental families were placed in seven classes described as follows:

R Resistant, with most of the seedlings showing infection types 0 to 3 and less than ten per cent having types X+ and 4–.

IR Intermediate-resistant, with infection types 0 to 3 on about three-quarters of the seedlings and types X+ and 4– on the remainder.

HR Heterozygous-resistant, with infection types 0 to 3 on nearly half of the seedlings, types X+ and 4– on a similar number and type 4 on a small percentage of plants.

H Heterozygous, with the three groups of infection types, viz. 0 to 3, X+ and 4– and 4, represented about equally or at least the 0 to 3 types balancing type 4 numerically.

I Intermediate, a class with nearly all of the seedlings showing types X+ and 4– and about ten per cent with other types.

HS Heterozygous-susceptible, with infection types 0 to 3 on a small percentage of plants, types X+ and 4– on nearly half of the seedlings and type 4 on the remainder.

IS Intermediate-susceptible, with few, any, seedlings showing infection typ 0 to 3; types X+ and 4– on about third of the plants and type 4 on th remainder.

S Susceptible, with types X+ and 4– o a small percentage of the seedlings an type 4 on the remainder.

An examination of Table I will make clea the method of classification. The distribu tion of the seedlings of a resistant F_4 famil according to type of infection, is shown the first line. The second line gives the di tribution of the seedlings of eight F_4 famili that were intermediate-resistant. These nin F_4 families were from the same F_3 line, an on the basis of their reaction, this line wa classified as intermediate-resistant. Only nin F_4 families of each F_3 line were inoculate and, as these families were in each cas chosen without regard to their possible ru reaction, their rust-class distribution is a fa indication of the amount of resistance or su ceptibility possessed by the parental F_3 lin they represent. The fourth and fifth lines the table show the infection-type distributio of the seedlings of F_4 families fro heterozygous-resistant F_3 lines. Further e amination of the results shows that all of th families of Pentad, the resistant parent, o curred in rust classes R and IR, but that onl 12 of the 99 F_4 families from heterozygou F_3 lines fell in these classes. If only on genetic factor was concerned here, one woul expect about 25 F_4 families to resemble Pe tad in rust reaction.

Table II gives the rust-class distribution the F_4 families of each F_3 line. When thes distributions are compared with the distribu tion of families of the parental varieties, is seen that transgressive segregation has o curred, for the means of some of the F_3 lin are farther apart than those of the parenta varieties. The mean of Pentad is betwee classes R and IR and that of Kubanka No. is at H class, giving a spread of from tw to three classes between the means. Th mean of F_3 line 857 is approximately a class IR whereas the mean of line 859 is ver close to class IS, a spread of four classes. B Student's (19) method, used on the results o the four series of inoculations, it was foun that there were significant differences in ru

TABLE II—Distribution of the F_4 families of 15 F_3 lines of the cross Kubanka No. 8 x Pentad according to the classification of their reaction to form 34 in the greenhouse.

Number of F3 line	Distribution of F4 families according to the classes determined by the reaction of F4 seedlings							Classification of F3 lines according to the rust-class distribution of F4 families
	R	IR	HR	H	HS	IS	S	
831		2	6					HR
835				1	1	2	5	IS
836			1	4	1	1	2	H
839	1		3	2	2	1		H
844			1	2	2	3	1	H
849		1	4	3	1			H
850		2	4	2	1			H
852			1	4	2	1	1	H
856			2	5	2			H
857	1	8						IR
858		1	4	3	1			H
859						6	3	IS
860	1	3	2	1	1	1		H
862		1	3	3	1	1		H
863		2	3	4				H
Kubanka No. 8		1	3	6	1	1	2	—
Pentad	8	6						

reaction between various F_3 lines. On the basis of these differences there appeared to be several genetically distinct types among the 15 lines, as follows:—(1) as resistant as Pentad, (2) intermediate-resistant, intermediate between Pentad and Kubanka No. 8, (3) intermediate, similar to Kubanka No. 8, and (4) intermediate-susceptible, approaching complete susceptibility. This distribution of the F_3 lines, indicates therefore, the existence of more than one genetic factor responsible for reaction to physiologic form 34.

In 1922, the writer and Aamodt investigated the inheritance of resistance to form 34 in a cross between Kubanka No. 8 and Pentad. Fourteen out of 246 F_3 families resembled Pentad in rust reaction, giving a ratio of 1 resistant to 16.5 heterozygous and susceptible. The distribution of the 15 F_3 lines tested in the present study shows 1 very much like Pentad and 14 in other classes, or a ratio of 1:14. The similarity between these ratios is apparent and the presence of two principal genetic factors is indicated. In both investigations susceptibility appeared to be at least partially dominant.

Results of Inoculating Seedlings of the Cross Mindum x Pentad with Physiologic Form 1.

The reaction of Mindum x Pentad F_3 hybrids to physiologic form 1 was studied in 1922 and 1923. The results obtained in 1922 were interpreted according to the reactions of the parental varieties (see Table III). Mindum was practically immune from form 1, the range of infection including types 0 and 1, but very few of the latter. Pentad was partially susceptible to form 1, the infection-type range extending from 1 to 4. Most of the Pentad plants showed types X and X+. The few type 1– infections that appeared may be ascribed to the effects of unfavorable local conditions in hindering development of rust on the seedlings.

Since so few type 1– reactions appeared on Mindum plants this type was considered intermediate between 0, which represented immunity, and types 2 to 4, which indicated various degrees of susceptibility. The hybrid families were classified on the basis of the relative proportions of seedlings showing immune, intermediate and Pentad-like types of infection, as follows:

I Immune, with a distribution of seedlings in infection types 0 and 1, like that of Mindum.

NI Near-immune, similar to I except that 5 to 10 per cent of the seedlings show types of infection outside of the range of Mindum.

HI Heterozygous-immune, comprising families with type 0 on a large majority of the seedlings.

H Heterozygous, consisting of families having about equal numbers of immune and intermediate-susceptible types of infection.

HIS Heterozygous - intermediate - susceptible, comprising families with a large majority of the seedlings having infection types like those of Pentad.

NIS Near-intermediate-susceptible, similar to IS but with type 0 infections on 5 to 10 per cent of the seedlings.

IS Intermediate-susceptible, with a distribution of seedlings in infection types 1 to 4, like that of Pentad.

S Susceptible, with type 4 on at least 90 per cent of the seedlings and few, if any, type 0 infections.

In Plate 1, the reaction of Mindum, Pentad, and representative F_3 families is shown.

A total of 166 F_3 families and 23 families of each parental variety were inoculated. The dominance of immunity was evident. Forty-five, or approximately one-fourth, of the hybrid families were immune, and among the 21 F_3 families that were susceptible five appeared to be distinctly more susceptible than any Pentad families. The results indicated the presence of one main factor dominant for immunity and probably a lesser factor dominant for partial resistance.

In 1923 F_4 seedlings of twenty-seven F_3 lines were inoculated with form 1 in duplicated series in the same manner as were the Kubanka No. 8 x Pentad hybrids. As the F_3 lines were chosen at random, they may be considered a fair average of the F_3 population tested in 1922. From 18 to 25 plants of each F_4 family were inoculated. A total of 198 F_4 families comprising 3926 seedlings were used in addition to adequate check cultures. The correlation between the two series of results was 0.605 ± 0.031. The data are summarized in Table III. It will be noticed that ten F_4 families in the heterozygous F_3 lines (classes HI, H and HIS) were classified as susceptible. That is, they were clearly more susceptible than any of the Pentad families. The data in 1922 were similar in this respect. The added results for both years gave a ratio of intermediate-susceptible to susceptible closely approaching 3:1.

The rust-class distribution of the F_4 families of each F_3 line is given in Table IV. Nine F_4 families of each F_3 line were tested, excepting those lines that seemed homozygous in the 1922 test, in which case only four families were used. The results obtained agreed with those of the previous year. Several gradations between immunity and susceptibility were represented in the F_3 lines. Only one line proved to be as resistant as Mindum and only two were intermediate-susceptible like Pentad. One line was distinctly susceptible.

The results obtained in 1922 and 1923 from the inoculation of Mindum x Pentad hybrids with form 1, agree closely, and show the presence of two genetic factors governing rust reaction, one a dominant factor for immunity epistatic to the other, a factor dominant for partial resistance.

Results of Inoculating Mindum x Pentad Hybrids with Physiologic Form 34.

Hybrids of the cross Mindum x Pentad were inoculated with form 34 in the F_3 and F_4 generations. Mindum is susceptible to form 34, the range of infection including types X+, 4– and 4 with the latter predominating strongly. Pentad is partially resistant to this strain, with a range of infection extending from type 0 to 4–. Of 734 inoculated plants of the parental varieties, 24 showed unexpected infection types. These plants were transplanted to the field nursery in the spring and the progeny inoculated the following fall in the greenhouse with form 34. In all cases the types of infection that appeared were within the normal ranges of the parental varieties, showing that the extreme infection types noted the previous year were due to environmental influences or to chance spores of another strain of rust. In 1922 strong necrosis was present on many of the Mindum

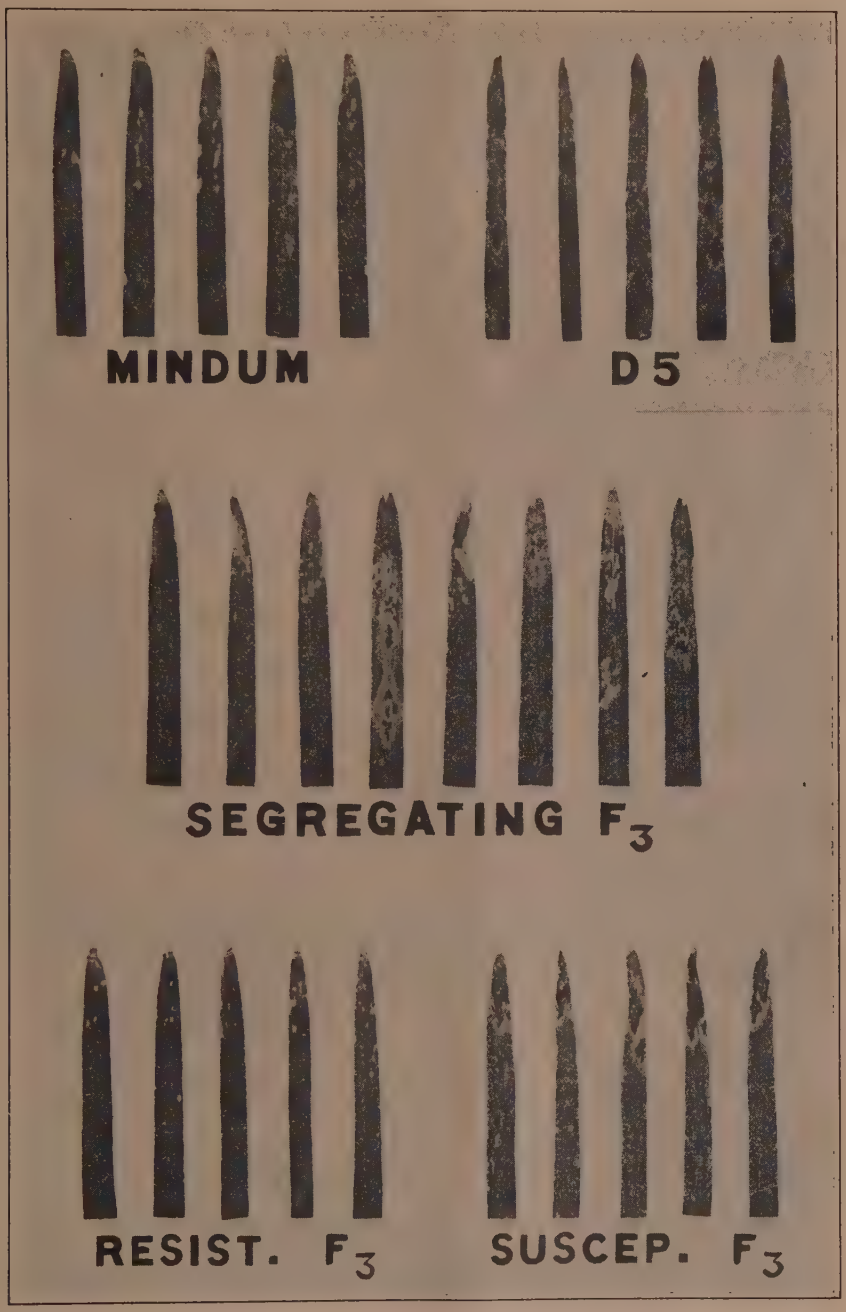

PLATE I.

The reaction of Mindum, Pentad, and F_3 families to physiologic form 1 in the greenhouse. Mindum is immune, normally giving a few hypersensitive flecks. Pentad is partially susceptible with types of infection varying normally from 1 to 4–. The F_3 families shown are typical heterozygous, resistant and susceptible hybrids.

TABLE III—Distribution of the F_4 seedlings of the cross between Mindum and Pentad according to the types of infection caused by form 1 in 1923.

Classes of parental F3 lines	Classes of F4 families and parental varieties		Distribution of F4 plants acording to the types of infection shown											Number of plants	Number of F4 families
			*	0	1–	1	X–	2	X	3	X+	4–	4		
I	F_4 families	I	52	22		1								77	4
NI	"	I	36	144	3	10								193	9
	"	NI	1	42	7	2	4							56	3
	"	HI	11	82	5		2		12	1			2	115	5
Total NI			48	268	15	12	6		12	1			2	364	17
HI, H and HIS	"	I	41	242	8	6								297	15
	"	NI	22	99	1	9	6		1	1	2		1	142	8
	"	HI	111	662	27	54	43	3	52	12	45	31	26	1066	53
	"	H	58	235	12	31	52	4	55	7	74	44	47	619	33
	"	HIS	30	46	8	6	8	1	45	2	44	51	25	266	14
	"	NIS	2	4		3			7		22	12	2	52	3
	"	IS	6	1		32	6		80	21	107	68	12	333	15
	"	S	4				3		4		35	51	95	192	10
Total HI, H & HIS			274	1289	56	141	118	8	244	43	329	257	208	2967	151
NIS	"	H		5		3						6	7	21	1
	"	HIS	2		1	7						1	1	12	1
	"	IS	1			3	3		6	3	43	12	3	74	5
	"	S								1	1	22	6	30	2
Total NIS			3	5	1	13	3		6	4	44	72	17	137	9
IS	"	NIS		4		2	1		6	2	4	4		23	1
	"	IS					27	1	51	15	106	33	8	241	12
Total IS				4		2	28	1	57	17	110	37	8	264	13
S	"	IS								1	19	1		21	1
	"	S	3				1		1		30	18	13	66	3
Total S			3				1		1	1	49	19	13	87	4
	Mindum	I	46	200	2	6			1					254	16
	"	NI	4	11		4								20	2
	"	HI		24		10	6							40	2
Total Mindum			50	235	2	20	6		1					314	20
	Pentad	HI				8			3					11	1
	"	HIS	3	10		8	10		21	1	8		1	62	3
	"	NIS	1	2			5		1		1	1		11	1
	"	IS	3	2		8	36		98	3	84	19	4	257	13
Total Pentad			7	14		24	51		123	4	93	20	5	341	18

* Seedlings listed in this column did not show infection but unlike the ordinary seedlings that escape infection, their inoculated leaves showed such symptoms as mottling, browning, dead tips and dead edges, which were typical of Mindum leaves inoculated with this strain of rust both in 1922 and in 1923. These seedlings, therefore, are counted with those in the O column.

TABLE IV—Distribution of the F_4 families of 27 F_3 families of the cross Mindum x Pentad according to the classification of their reaction to form 1 in the greenhouse.

Number of F3 family	Distribution of F4 families according to the classes determined by the reaction of F4 seedlings								Classification of F3 lines according to the	
	I	NI	HI	H	HIS	NIS	IS	S	Rust-class distribution of F4 families	Reaction of seedlings in F3
866	1	1	5	1			1		H	HI
867	1		3	4			1		H	HI
868	1		2	4			2		H	HI
869			4						HI	I
870			1	2	3		1	1	H	H
871							4		IS	IS
873	1	2	1						NI	I
874		1	1	1				1	H	I
875	3		1						NI	I
878	5	1	3						NI	NI
879			4	2	2		1		H	HI
881			4	4	1				H	HI
882			1	1	1		3	1	H	HI
884	1	1	3	2	1		1		H	HI
886	1		2	3	3				H	HI
887	2		4	1			1		H	HI
892	1	1	2	1				3	H	HI
894	1	1	3	2			1	1	H	HI
895	2	1	2	2	1	1			H	HI
896	4								I	I
897			3	3	1	1		1	H	H
898						1	7		IS	NIS
899	2	1	5					1	H	HI
903							1	3	S	S
904		1	3			1	4		H	HI
906	2		1					1	H	I
907				1	1		5	2	IS	H
Mindum	16	2	2							
Pentad			1		3	1	13			

plants, and susceptible hybrids. The necrotic areas usually bordered large confluent uredinia. (See Plate 2). In 1923 very little necrosis accompanied type 4 infections. It is probable that the appearance of necrosis on susceptible plants is due to environmental influences.

A total of 110 F_3 families and 33 families of each parental variety were inoculated in 1922. The method of interpreting results, and the rust classes used were the same as those employed for the Kubanka No. 8 x Pentad hybrids. On the basis of the parental variety reactions the ratio of resistant: heterozygous: susceptible is 2:8:1, which indicates the presence of more than one genetic factor.

Seedlings of the F_4 families of the same 27 F_3 lines that were tested for their reaction to form 1 were inoculated with form 34 in 1923. A total of 217 F_4 families comprising 3859 seedlings were used. Two plantings were made from seed of each F_4 family giving two complete series of results between which there was a correlation of 0.378 ± 0.039. The detailed data are omitted here since they resembled in general the results obtained when Kubanka No. 8 x Pentad hybrids were inoculated with form 34. The rust-class distribution of the F_4 families of each F_3 line is given in Table V. At least two of the IR F_3 lines (866 and 899) approached Pentad in their reaction. Several other lines, Nos. 867, 873, 882, and 894, were less resistant than Pentad with ranges extend-

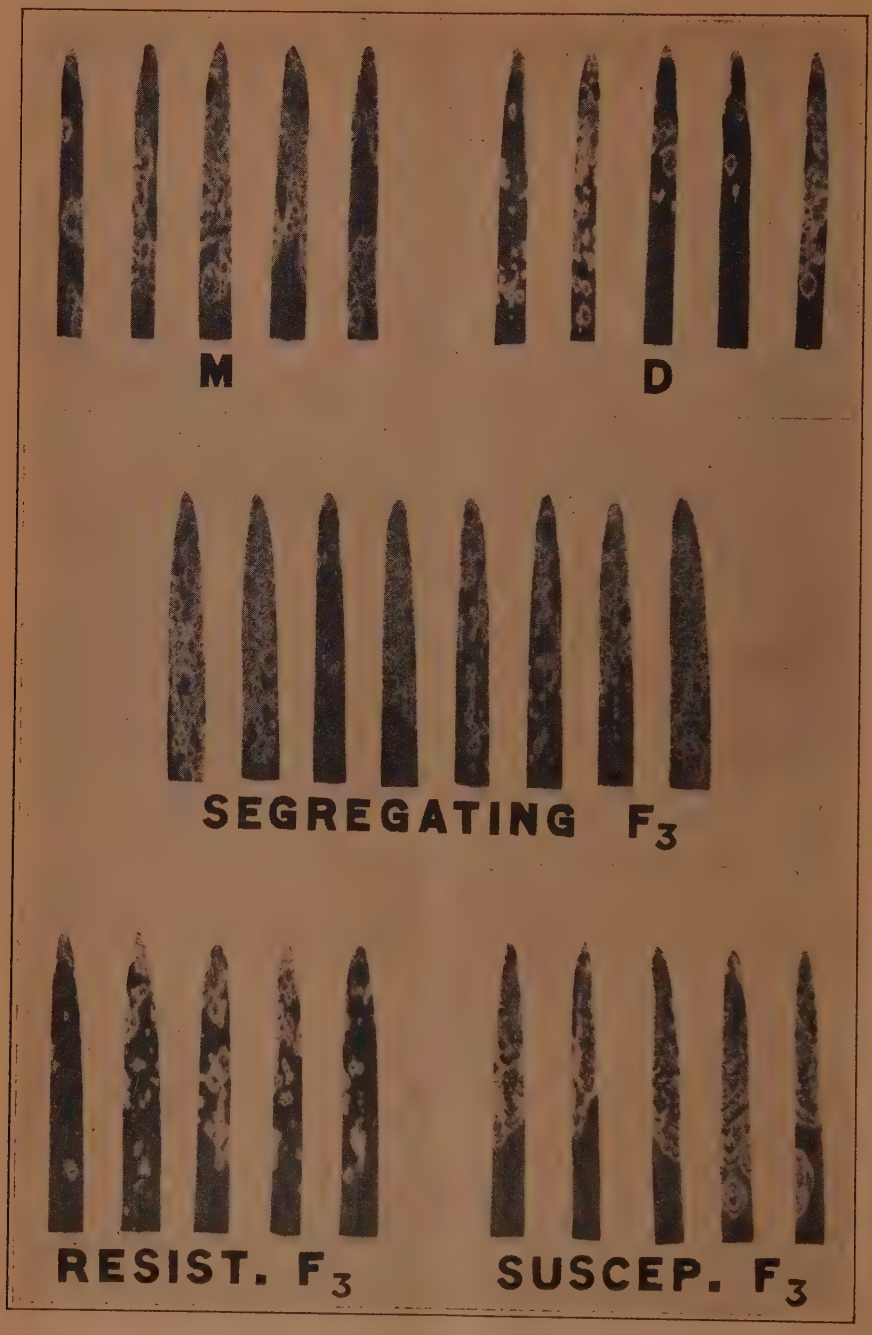

PLATE 2

The reaction of Mindum, Pentad, and F_3 families to physiologic form 34 in the greenhouse. M= Mindum, the susceptible parent with normally a range of infection type from X+ to 4. D= Pentad, the resistant parent, giving types of infection from 0 to 4–. The hybrids shown are typical heterozygous, resistant and susceptible F_3 families.

TABLE V—Distribution of the F_4 families of 27 F_3 families of the cross Mindum x Pentad according to the classification of their reaction to form 34 in the greenhouse.

Number of F3 family	Distribution of F4 families according to the classes determined by the reaction of F4 seedlings.								Classification of F3 lines according to the	
	R	IR	HR	H	I	HS	IS	S	Rust-class distribution of F4 families	Reaction of seedlings in F3
866	1	6	1						IR	
867		3	3	2					HR	
868			1	3	1	1	2	1	H	H
869			1	4	2	2			H	
870			1	1	2	2	2	1	H	
871	1	2	6						HR	
873		3	4	2					HR	
874	1	1	1	3			2		H	HR
875			2	4		1	1	1	H	
878		2	1	1	3		1		H	
879	1	2	1	2		1	2		H	
881				5		1	2	1	H	
882		1	7	1					HR	
884		1	5	2		1			H	
886			3	2	2	2			H	HR
887	1	2	2	2	1		1		H	
892				1	3		2	3	HS	
894		2	5	1	1				HR	HS
895	1		1	2		1			H	HR
896	1	1		3	1		1		H	
897		1	2	6					H	
898	1	1	1		1				HR	R
899		3	1						IR	R
903		4	5						IR	NR
904	1	3	1	2			1		HR	
906	1	2	2	1					HR	
907			4	1		4			H	HS
Mindum				1		4	5	12		
Pentad	12	7	1							

ng from IR to I. One line (892) approached Mindum in susceptibility. Most of the remaining lines appeared to be heterozygous. These results seem to indicate the presence of at least two factors for rust reaction.

In Table VI the distribution of F_3 families in 1922 is compared with that of the 27 F_3 lines tested in 1923, also with the distribution of F_4 families from H F_3 lines. As far as the means of these distributions are concerned, no significant differences appeared. It will be noticed that the intermediate rust class I, was not used for form 1 results. This new class was created to accommodate a few F_4 families that appeared to be intermediate in reaction, yet not heterozygous.

The 12 F_3 lines that were classified I and H were comprised of 127 F_4 families. Supposing that a single allelomorphic pair of factors determined the reaction to form 34, then 32, or roughly one-fourth, of the F_4 families should have appeared resistant and a similar number susceptible. On the basis of the reactions of the parental varieties, and disregarding extreme deviations, the number of apparently resistant F_4 families was 15 and the number that seemed to be susceptible was 34. The ratio of resistant: heterozygous: susceptible approximates 1:10:2. A single genetic-factor difference obviously does not more satisfactorily explain the results for F_4 material than it accounted for the results from the F_3 generation.

TABLE VI—Comparison of F_3 and F_4 distributions of Mindum x Pentad families in the various rust classes according to the results obtained from inoculation with form 34 in the greenhouse in 1922 and 1923.

Hybrids families and parental varieties	Year	Distribution of families in the various rust classes. R	IR	HR	I & H	HS	IS	S	Number of families
F_3 lines	1923		4	7	12	4			27
F_4 families from H (Heterozygous)									
F_3 lines	1923	5	10	25	53	16	14	4	127
F_3 families	1922	16	3	29	23	19	10	9	109
Mindum	1923				1	4	5	12	22
	1922					2	2	29	33
Pentad	1923	12	7	1					20
	1922	30	1	2					33

TABLE VII—Distribution of the F_5 families of 26 F_4 families of the cross Mindum x Pentad according to the classification of their greenhouse reaction to physiologic form 21.

Number of F4 family	Dstribution of F5 families according to the classes determined by the reaction of F5 seedlings R	IR	HR	I & H	HS	IS	S	Classification of F4 families according to the reaction of seedlings to form 21 in F5	form 34 in F4
716		4						IR	R
958		3						IR	R
719	1	4				1		HR	IR
732	1		2			1		HR	IR
770	1	4						IR	IR
772				5		1		H	IR
930	3	2						R	IR
717			2	3				H	HR
767	3	1						R	HR
769	1		2	1				HR	HR
779			1	2	1			H	HR
882	1	4						IR	HR
932	4	1	1					IR	HR
745						2		IS	H
870				2		1	1	HS	I
828						2	5	S	HS
971		1	1	2	1	1		H	HS
784				2	3	1		HS	IS
789		1	1	2	1	1		H	IS
874							4	S	S
Mindum						5	5	S	S
Pentad	7	2						R	R

Results Obtained with Physiologic Form 21.

Physiologic form 21 was used exclusively in the 1924 work. It was desirable to use a form of rust to which Mindum is susceptible and Pentad resistant in order to learn whether the factors determining the resistance of Pentad to form 34 also produced resistance to the other strain. Form 21 is very similar to form 34 in its reaction upon the differential hosts. The only significant difference being that it produces no infection on Kanred, whereas that variety is quite susceptible to form 34.

Twenty-six F_5 families, of the cross Mindum x Pentad, representative of the various rust classes obtained in 1923 with form 34, were used with form 21. The results are summarized in Table VII. Plantings of each family were duplicated giving two complete series of results between which there was a correlation of 0.691 ± 0.036. A total of 1,820 hybrid plants and 705 seedlings of the parental varieties were inoculated. Representative reactions are shown in Plate 3. The actual classification of each F_5 family was based on the reaction of about 35 seedlings. None of the families that showed a definite tendency towards resistance to form 34 occurred in susceptible classes in their reaction to form 21. Similarly, none of the families that tended toward susceptibility to form 34 appeared in resistant classes in their reaction to form 21. It is evident that the genetic condition responsible for resistance and susceptibility to form 34 is similar to the condition governing the reaction to form 21.

The Reaction of Mindum and Pentad to Individual Physiologic Strains in the Field.

In the spring of 1922, three small plots, each containing Mindum, Pentad, and Marquis in short rows, were sown about 12 rods apart near the center of a two-acre block of corn located a half mile east of the rust nursery at University Farm. When the wheat seedlings were about six inches high a frame was erected about each plot and covered on sides and top with a single ply of muslin. A suspension of spores of form 34 propagated in the greenhouse on wheat seedlings was sprayed on the growing plants in the muslin cages at intervals of about three days for two weeks preceding and one week following the time of heading. Spraying was done with a small hand sprayer in the early evening when dew was commencing to fall. No infection appeared on any of the varieties until two weeks after heading.

When the plants were beginning to mature, notes on the rust infection of the leaves and stems were taken. Marquis was very heavily infected. Mindum also was susceptible, but the uredinia were larger, less numerous, and more confluent. Pentad appeared quite resistant (See Plate 4) with a type of infection similar to that usually observed on Khapli, that is, the pustules were very small and generally with epidermis intact. To make certain that the rust which appeared on Mindum in the field cages was form 34, spores were transferred from several Mindum plants to seedlings of the twelve differential varieties including Mindum and Pentad, planted in a duplicated series in the greenhouse. The results were compared with those of a series of differentials inoculated with form 34 that had been kept in the greenhouse. The agreement was excellent although there was evidence of slight mixture.

During the season of 1923, the cage test was repeated with form 21 instead of form 34. When final notes were taken it was found that the percentages of infection on Marquis, Mindum, and Pentad were 85, 50 and 0, respectively. Rust spores from Mindum were placed on differential varieties of wheat in the greenhouse as with form 34. Aside from evidence of slight mixture on Acme, Kanred, and Kubanka, the rust from the field cage gave the same reaction as spores from form 21 that had been kept in the greenhouse.

The cage test, although crude, gave satisfactory results in that there was little doubt as to their interpretation. The test demonstrated that the reactions of Mindum and Pentad to physiologic forms 34 and 21 in the field agree with the results obtained when seedlings of these varieties are inoculated with the same forms in the greenhouse. There are some objections to the cage method of test. It is possible that spores of other rust forms were blown through the corn on to the muslin top of the cage and were washed through by dew or rain. Also the heat, light, humidity, and air circulation conditions inside the muslin cage are not entirely normal, therefore, the results of such a test cannot be considered comparable to field results. However, from the results of the epidemiology studies of Levine (1919), one may assume that no part of the spring-wheat area during the late spring and summer is free from windborne spores of probably several physiologic forms of rust. Consequently, if the reaction of certain varieties of wheat to a single physiologic form of rust under field conditions in this area is desired, it cannot be obtained without the use of protection of some sort.

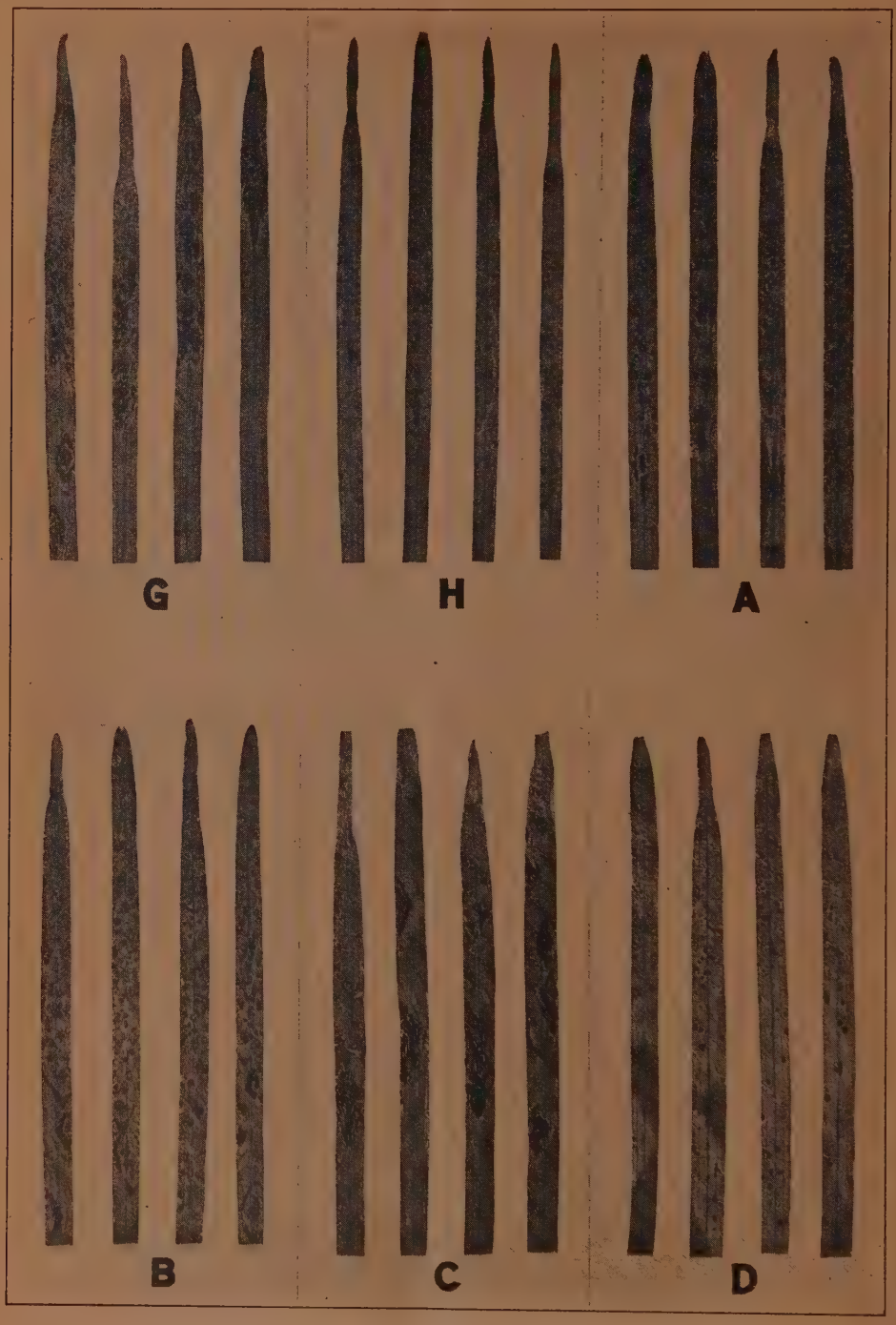

PLATE 3

The reaction of Mindum, Pentad, and F_5 families to physiologic form 21 in the greenhouse. G= Mindum, the susceptible parent, normally giving types of infection from 3– to 4. H= Pentad, the resistant parent, with a normal range of infection types from 3– to 4–. A and B= Typical intermediate-resistant hybrid families. D and C= Typical resistant and susceptible hybrid families, respectively.

PLATE 4

The reaction of Marquis, Pentad, and Mindum to physiologic form 34 in a segregated field plot protected by muslin.

From left to right are shown homologous portions of the culms of Marquis (for comparison only), Pentad and Mindum, respectively.

Seed Color in Relation to Rust Reaction.

Since Pentad, the most resistant parental variety used, is red-seeded and both Kubanka No. 8 and Mindum are white-seeded, it was of interest to observe whether the factors for seed color and those for rust reaction were linked. Classification of 599 F_2 plants of Mindum x Pentad gave a ratio of 2.99 : 1.01, with red seed color dominant. In Table VIII, the 1922 classification of F_3 families, from red-seeded and from white-seeded parents, according to the reaction of these families to physiologic forms, 1, 17, and 34 is given. The rust classes are placed in three general groups for convenience. A study of the distributions in the table reveals a lack of correlation between seed color and rust reaction.

NURSERY INVESTIGATIONS AND THE CORRELATION OF RUST REACTION WITH OTHER CHARACTERS.

During the season of 1923 a study was made of various agronomic characters of F_4 hybrids of the crosses Kubanka No. 8 x Pentad and Mindum x Pentad, in two field nurseries in each of which all of the F_4 families were planted. About 30 plants of each F_4 family grew to maturity. The parents of the crosses used may be described as follows with respect to the characters studied; Mindum was susceptible to rust in the rust nursery, and, compared with Pentad, was more erect, taller, and slightly later in heading. Kubanka No. 8 was weakly susceptible to

TABLE VIII—Distribution of Mindum x Pentad F_3 families from red-seeded and white-seeded parents in the rust classes according to the reaction of F_3 seedlings to three physiologic forms of rust in 1922.

Cross	Seed Color	Physiologic form of rust	Distribution of F3 families in the rust classes			Number of families*
			I and R to NI and IR	HI and HR to HIS and HS	NIS and NS to S	
Mindum x Pentad	Red	17	30	39	12	81
"	White	17	27	43	15	85
"	Red	1	3	51	31	85
"	White	1	4	61	39	104
"	Red	34	11	48	21	80
"	White	34	9	20	1	30

* Many of the red-seeded F_2 plants were not used in the greenhouse tests.

PLATE 5

The reaction of Mindum, Pentad, and Kubanka No. 8 in the rust nursery under epidemic conditions created artificially by spraying with a mixture of seven Northwest physiologic forms. No. 1= Mindum, susceptible. No. 2= Pentad, resistant. No. 3= Kubanka No. 8, partially susceptible.

ust, about the same as Pentad in erectness nd time of heading, and between Mindum nd Pentad in height of plant. Pentad was uch more resistant to rust under field con- itions than either Mindum or Kubanka No. . (See Plate 5.)

Rust Infection in the Nursery.

In the rust nursery, a satisfactory epidemic f stem rust was created artificially by spray- ng with a mixture of spores of physiologic orms 1, 9, 17, 18, 19, 21 and 34, which were ollected in the North-central States. Owing o the favorableness of the season for rust nfection there also was a very fair epidemic n the agronomy nursery. Rust notes were aken on all families grown in the agronomy ursery, but notes on individual plants were aken only on about half of the total number f families. A rust note was taken on every lant in the rust nursery.

There was a correlation of 0.643 ± 0.039 etween the results for the two series of Min- lum x Pentad families and of 0.139 ± 0.081 or the Kubanka No. 8 x Pentad families. Owing to the lack of significance of the lat- er correlation the Kubanka No. 8 x Pentad ybrids were not analyzed further for the node of inheritance of rust reaction. The lants in the rust nursery were graded as, A (no rust to a trace), B (up to 20 per cent), C (heavy) or D (very heavy). Relatively ew plants graded A and a negligible number raded D. Pentad plants occurred in grades A and B with a small proportion in C. Kubanka No. 8 plants fell in all four grades but chiefly in grades B and C. Mindum plants were placed in grades B and C, the latter class having about 90 per cent of the total.

On the basis of the distribution of plants in the four grades used in field classification, the F_4 families were placed in classes 1 to 9. In class 1, were placed families of which all plants graded A. Families with about two-thirds of their plants in grade A and one-third of them in grade B were placed in class 2, and so on to class 9, that contained famil- ies of which all plants graded C or D. The distribution of Kubanka No. 8 and that of Pentad overlapped extensively. Between Pen- tad and Mindum there was no overlapping; the means were 3.9 and 8.7, respectively.

The distribution of the F_4 families of each F_3 line of Mindum x Pentad with respect to rust nursery classes is shown in Table IX. Of the 27 F_3 lines, one (896) appeared to be similar to Mindum, but no F_3 line proved as rust resistant as Pentad. If one or even two genetic factors governed reaction to all of the physiologic forms of stem rust present it would be expected that more of the hybrid lines would show a close approach to the reaction of either or both of the parental varieties. It would seem, then, that at least three factor pairs were involved.

For the study of relationships between characters the F_4 families resembling Pentad and those resembling Mindum in rust reaction in the nursery were selected. A total of 37 families fell within the Pentad range in both nurseries and were considered to be of Pentad type. These will be designated as "field resistant" families. A total of 107 F_4 famil- ies were placed in classes 8 and 9, which constitute the range for Mindum. Of these, 46 appeared to be fully as susceptible as Mindum and will be called the "field-susceptible" families.

OTHER CHARACTERS

The detailed data obtained in the study of the characters, erectness of plant, height of plant and earliness of heading are not pre- sented here owing to lack of space. This part of the work may be summarized as fol- lows:—

Erectness of Plant.

Notes on erectness of culm were taken for all families grown in the two nurseries. The correlation between the two series of rows was 0.389 ± 0.037 for Mindum x Pentad F_4 families and 0.537 ± 0.041 for Kubanka No. 8 x Pentad. The results for the two series were averaged for each F_4 family. Kubanka No. 8 and Pentad are very similar in erect- ness, their means both being 70 per cent. Mindum averaged 80 per cent. Transgressive segregation occurred in both crosses. Some Kubanka No. 8 x Pentad F_3 lines appeared to be less erect, and others considerably more erect, than either parental variety. Three Mindum x Pentad F_3 lines were lower than Pentad in percentage erectness, and three were higher than Mindum. The results indicated that in both crosses erectness is dependent on several heritable factors, part of which are present in one parent and part in the other.

TABLE IX—The distribution of the F_4 families of each F_3 line of Mindum x Pentad with respect to the F_4 seedling reaction to several physiologic forms of rust in the rust nursery.

F_3 lines and parental varieties	Rust Classes									Mean Class
	1	2	3	4	5	6	7	8	9	
866				1	1	1	4	1	1	6.7
867					2	2	1	4		6.8
868						1	1	3	4	8.1
869						1	3	3	2	7.7
870					1		1	4	1	7.6
871						1	1	6	1	7.8
873					1	1	2	5		7.2
874					1		2	4	2	7.7
875					1	2	5	1		6.7
878						1	1	5	2	7.9
879							1	4	4	8.3
881					2	2	2	2		6.3
882					2	2	3	1		6.4
884			1		1	1	4	2		6.4
886					2	3	2	1	1	6.5
887						1	3	4	1	7.5
892			1	2	2	1	1	1	1	5.7
894						1	3	3	2	7.7
895					2	1	2	4	1	7.1
896								5	4	8.5
897			1		2	2	2	1	1	6.2
898					4	2	1	1	1	6.2
899						1	2	2	3	7.9
903					3	1	5			6.2
904			1	2	3	1	2			5.1
906						2		6	1	7.7
907					2	2	4	1		6.4
Total			4	5	32	33	58	74	33	7.1
Mindum								3	10	8.7
Pentad	1		3	7	1		1			3.9

TABLE X—Percentage values computed from he greenhouse and nursery data to illustrate the relationships between rust reaction in the field nursery and other characters of Pentad and Mindum.

Characters with respect to which the percentages were computed	Percentage of the field-susceptible families that resembled Pentad *	Percentage of the field-resistant families that resembled Pentad *	Percentage of the field-resistant families that resembled Mindum **	Percentage of the field-susceptible families that resembled Mindum **
Reaction to form 1.....	10	49	13	30
Reaction to form 34.....	23	33	9	16
Erectness of plant.....	23	45	3	15
Height of plant.....	26	62	8	36
Date of heading	65	100	0	35
Average	29.4	57.8	6.6	26.4

* Similar to or else more extreme than Pentad.

** Similar to or else more extreme than Mindum.

Height of Plant

The height of the F_4 plants in the agronomy nursery was taken in inches and the mean height calculated for each F_4 family. In the rust nursery, individual plant heights were taken for 108 of the Mindum x Pentad families. The correlation between the two series of results for these families was 0.613 ± 0.041. The Kubanka No. 8 x Pentad height results were not used for study owing to the great variability of Kubanka No. 8. The average height of Mindum was 40.3 inches and of Pentad, 34.6 inches. No Mindum x Pentad F_3 lines exceeded Mindum in height but six lines were shorter than Pentad, indicating the presence of more than one genetic factor for height.

Time of Heading.

Time of heading notes were taken on all F_4 families in both nurseries. The correlation between the rust nursery series and the agronomy nursery series was 0.532 ± 0.031 for Mindum x Pentad families and 0.359 ± 0.051 for Kubanka No. 8 x Pentad. Nothing definite was learned concerning the inheritance of earliness in the Kubanka No. 8 x Pentad cross. Both parent varieties headed 61 days after the time of sowing. Transgressive segregation occurred in the Mindum x Pentad material although Mindum headed only one day later than Pentad. The F_4 families of 9 F_3 lines headed from 2 to 3 days earlier than Pentad and the families of one F_3 line averaged 1½ days later than Mindum. The results pointed to the existence of more than one genetic factor concerned with earliness.

RELATIONSHIPS BETWEEN CHARACTERS

Almost all possible relationships between the various characters were investigated and some interesting correlations were found. There was a negative correlation between rust reaction in the nursery and the reaction to form 1 in the greenhouse. That is, hybrid families which were resistant in the rust nursery tended to be susceptible to form 1 in the greenhouse, and families that were susceptible in the nursery tended toward immunity in their greenhouse reaction to form 1. No correlation was found between nursery rust reaction and reaction to forms 21 or 34 in the greenhouse.

To investigate further any relationship existing between rust reaction in the nursery and in the greenhouse, a limited test was conducted in the greenhouse in 1924. Five F_4 plants that appeared almost immune (A class) from rust infection in the rust nursery and 5 plants that were very heavily infected (D class) with rust were selected from the Kubanka No. 8 x Pentad F_4 population. Similarly 10 plants were selected from Mindum x Pentad material. A duplicate test of the greenhouse reaction to form 21 on F_5 seedlings from seed of each of these twenty plants was run in March, 1924. The results showed a complete lack of correlation between either resistance or susceptibility in the field and the reaction of the hybrids to form 21 in the greenhouse.

The relationships between nursery rust reaction and other characters of Mindum and Pentad are shown in Table X. The table is really a combination of two tables, one having to do with Pentad characters and the other with Mindum characters. The characters listed at the left of the table are those with respect to which the percentages were computed. For example, only ten per cent of the hybrid families that reacted like Mindum in the nursery resembled Pentad in their reaction to form 1 in the greenhouse, but 49 per cent of the families that reacted like Pentad in the nursery resembled Pentad in their nursery reaction to form 1. Again, the percentage of field-susceptible families that resembled Pentad in height of plant was 26 but the percentage of field-resistant families that resembled Pentad in height was 62. If there was no linkage between the factors governing nursery rust reaction and those concerned with height of plant, these two percentages should be equal in value. The fact is that one is much greater than the other. A further study of the table shows that there is a correlation between rust reaction in the nursery and all of the characters of Pentad. Likewise, Mindum characters are correlated with susceptibility to rust in the nursery.

There appeared, then, to be a slight linkage between the inherited factors which govern resistance to rust under field conditions, plant height, erectness of plant and time of heading. The hybrids which resembled Pentad in rust reaction also tended to resemble

Pentad in other characters. From a plant-breeding standpoint the linkage of rust resistance with the undesirable characteristics of Pentad lowered the proportion of desirable families in the crosses studied.

GENERAL CONSIDERATIONS

Several hundred F_4 plants of the cross Mindum x Pentad that appeared to possess desirable combinations of the parental characters were selected for test in the nursery in the F_5 generation. All of these plants were as resistant as Pentad in the rust nursery in 1923, and belonged to the white-seeded, F_4 families that were erect, fairly uniform for date of heading, and satisfactory for plumpness of seed; many of them came from F_4 families that seemed as uniformly resistant to stem rust as did Pentad. It is hoped that strains will be obtained from this material that will combine the desirable erectness, yield, seed color, and baking quality of Mindum with the rust resistance of Pentad.

SUMMARY

1. A study was made of the parasitic capabilities of four physiologic forms of *Puccinia graminis tritici* on F_3, F_4 and F_5 progeny from crosses between three varieties of *Triticum durum* (Kubanka No. 8, Mindum, and Pentad).

2. The physiologic forms, 1, 17, 21 and 34, employed in this study were consistant in their reaction on twelve differential varieties of wheat.

3. There were in all 23,620 hybrid seedlings and 3,680 seedlings of parental varieties inoculated during the course of the investigations.

4. A separate set of 8 to 20 seedlings for each F_3 family was grown for use with each physiologic form of rust. Plantings for each F_4 and F_5 family were replicated at least once, giving a total of 10 to 35 infected seedlings in each Mindum x Pentad family, and from 25 to 50 in each Kubanka No. 8 x Pentad family.

5. Pentad was resistant and Kubanka No. 8 slightly susceptible to form 34. F_4 families were obtained which appeared to be homozygous for the parental types of reaction, while others seemed to be heterozygous. Some families were distinctly more susceptible than Kubanka No. 8 and appeared to be homozygous. There appeared among the F_3 lines tested in F_4 several different types with respect to reaction to form 34. Apparently Kubanka No. 8 and Pentad contain different factors for resistance, the factor in Pentad producing more resistance than the one in Kubanka No. 8. The susceptible hybrids probably contain the recessive allelomorphs of these two factors.

6. In reaction to form 1, Mindum is very resistant and Pentad is slightly susceptible. The reaction of Mindum x Pentad hybrids was tested in the F_3 and F_4 generations. Families appeared which were homozygous for parental types. Other families were heterozygous, and some were clearly more susceptible than Pentad. Several different types of resistance, heterozygosity and susceptibility appeared among the 27 F_3 lines tested in F_4. The results indicated the presence of two independently inherited factors, one of them dominant for immunity and present in Mindum, the other almost completely hypostatic to the first, but dominant for slight resistance, and carried by Pentad.

7. Mindum x Pentad hybrids were inoculated with form 34 in the F_3 and F_4 generations. Mindum is susceptible and Pentad resistant to this form. Several gradations between resistance and susceptibility appeared in the F_3 and F_4 families. None of the 27 F_3 lines tested in F_4 proved to be like Mindum or Pentad, although they had been selected at random for the 1923 test, but there appeared to be among them several intermediate grades for rust reaction. The results indicated the presence of more than one factor for resistance.

8. Mindum is susceptible and Pentad resistant to form 21. In 1924 a limited test of families that occurred in various classes of reaction to form 34 was made on F_5 seedlings with form 21. The results were similar to those secured with form 34 and indicated that the factors governing resistance to form 21 were probably the same as those producing resistance to the other form.

9. Reaction to rust was found to be inherited in the same manner as other characters. Several factors were involved and environ

ental influences modified the expression of e rust reaction.

10. Fairly satisfactory agreement was und between the rust results in the green- use one year and those of the next. Ap- arently it would be necessary to use larger mbers of seedlings to determine accurately e genetic class of any particular family.

11. No relation was found to exist between st reaction and seed color.

12. A study was made of various agron- nic characters of F_4 hybrids of the crosses, ubanka No. 8 x Pentad and Mindum x Pen- d, in two field nurseries, in each of which l of the F_4 families were sown.

13. A heavy rust epidemic was obtained in e rust nursery by spraying with a mixture spores of seven Northwest physiologic rms. There was also a good epidemic in e agronomy nursery due to the favorable- ss of the season for rust development.

14. The results for Mindum x Pentad hy- ids indicated the presence of more than e genetic-factor difference for each of the aracters, rust reaction in the nursery, erect- ss of plant, height of plant, and earliness of eading.

15. There was a negative correlation be- een rust reaction in the nursery and the action to form 1 in the greenhouse. No rrelation was found between reaction to st under nursery conditions and reaction to rm 34 or 21 in the greenhouse.

16. There appeared to be a slight linkage tween the inherited factors which govern sistance to rust under field conditions, plant ight, erectness of plant, and time of head- g. The hybrids which resembled Pentad in st reaction also tended to resemble Pentad other characters.

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Seed Inoculation and Its Limitations.

A WARNING

Especially at this season of the year, when spring seeding is under way, the question of seed inoculation with cultures of bacteria receives considerable attention. As various cultures are advertised, some with unwarranted claims, it seems desirable that our Canadian farmers and growers should be informed as to what extent the practice of seed inoculation has received sound scientific approval, and just what its limitations are in the light of present day knowledge. With this in view the following statement has been prepared jointly by F. C. Harrison, Principal and Professor of Bacteriology, Macdonald College; D. H. Jones, Professor of Bacteriology, Ontario Agricultural College; and A. G. Lochhead, Dominion Agricultural Bacteriologist, Ottawa:

In all agricultural soils bacteria are necessary for the best production of any crop. They play an indispensable part in the preparation of plant food, helping to change it from an unavailable form into a soluble form capable of being used by the growing plant.

It is especially in connection with the work of supplying the nitrogen requirements of the plant that bacteria are important. While certain kinds convert nitrogenous materials in the soil itself into forms which can be taken up by the plant, other bacteria are able to enrich the soil and the plant by gathering nitrogen from the air. Some of these work independently in the soil, others in association with the roots of plants of the leguminous type, in the nodules or swellings on the roots of vigorous plants of this kind.

With the single exception of the legume bacteria there is no indication of a scarcity of useful bacteria in an otherwise good soil. If they are lacking in a soil the soil does not favour their growth, due to some such condition as excessive alkalinity, acidity or some other defect. Only when such a defect is corrected will the useful bacteria flourish. Adding bacteria other than legume bacteria will therefore be superfluous in normal soils and of little or no avail in abnormal soils.

With legume bacteria, however, the case is different. In many instances there may be an actual deficiency of these in a soil, a deficiency which may be remedied by inoculation. With each variety of legume are associated its own special bacteria, the presence of which is necessary if the plant is to benefit from the supply of nitrogen in the air which the bacteria make available, and only in some special cases will one variety of bacteria be of use to another kind of legume.

If a crop has been growing successfully in a field, and shows the presence of well-developed root nodules, the soil contains the proper bacteria for this crop, and inoculation is not so necessary for another similar crop as when the crop is being cultivated for the first time or where previous crops have been unsuccessful. It will then be of distinct advantage to inoculate the seed. Even in such cases inoculation cannot be said to be a sure cure for all ills. Success will be most probable if the other soil conditions are at their best and inoculation is thus really an aid to, and not a substitute for good farming methods.

Much scientific research has been devoted to the question of soil and seed inoculation, but only with legume cultures has the practice been placed on a sound basis and received unbiased approval from agricultural scientists. While legume inoculation then, is to be encouraged, yet in order that this practice may not be brought into disrepute by lack of success with cultures claimed to be of benefit for miscellaneous non-leguminous crops we consider it important that the public should understand as fully as possible the limitations of bacterial inoculents, and we therefore warn farmers and other growers not to expect results from other cultures which cannot be endorsed.

(Experimental Farms Note.)

Does Artificial Tripping of Alfalfa Blossoms Increase Seed-Setting?

(A Preliminary Report)

W. D. HAY

Dominion Experimental Station, Lethbridge, Alberta.

The lack of seed production in alfalfa oughout the prairie provinces has been con- ered by many growers and investigators be due to failure of the blossoms to trip. fferent theories have been advanced to plain this lack of tripping, two of the st common ones being, first, the scarcity bees and other insects which trip alfalfa ssoms readily when visiting them in search nectar and, second, unfavorable weather nditions during the growing season and ticularly when the plants are in blossom l ready for tripping.

From experiments carried out elsewhere, l from observations made at the Lethbridge perimental Station as well as at other tions, it has been found that the honey is of practically no value for tripping lfa. In the United States, Westgate observ- 500 visits of honey bees to alfalfa flowers, l tripping occurred only once. Different es of wild bees, however, and probably a other insects, do trip a considerable portion of the blossoms visited, but they present in Western Canada in only very ll numbers.

n order to determine whether or not arti- al tripping does increase the number of seed pods set, a comparison from the standpoint of seed production was made between a certain number of flowers which were artificially tripped and an equal number of flowers which were untripped. Tripping was done on each of the last four days in July, and each day was divided into four periods for tripping, namely, 8 o'clock to 10 o'clock; 10-12; 2-4 and 4-6. In each of these four periods plants were selected and at two different places on them, generally on opposite sides, a stem was chosen having on it two panicles as nearly similar in all respects as possible, and with flowers ready for tripping. Eight flowers were retained on each of these panicles and all others were removed. The flowers on one of the panicles were then tripped, by means of a toothpick, and those on the other were left untripped to serve as checks. The color of flower and stage of maturity were also recorded at the time of tripping.

When these plants had had sufficient time to set seed, they were examined and the seed pods were counted. The table below shows the results obtained. It should be kept in mind that in each period four plants

NUMBER OF SEED PODS FORMED WHEN FLOWERS WERE TRIPPED AT DIFFERENT TIMES DURING THE DAY

Date	Time of Day 8-10 a.m.		10-12 a.m.		2-4 p.m.		4-6 p.m.		Total per Day	
	Tripped	Untripped	Tripped	Untripped	Tripped	Untripped	Tripped	Untripped	Tripped	Untripped
ly 28			6	6	12	2	8	5	26	13
" 29	9	8	4	0	8	8	7	3	28	19
" 30	0	0	0	2	0	0	2	1	2	3
" 31	12	6	9	10	9	5	5	1	35	22
Totals	21	14	19	18	29	15	22	10	91	57

were selected; four panicles on each plant and each panicle retained eight flowers, which meant a total of 128 flowers, sixty-four of which were tripped and sixty-four untripped. During the four days, or fifteen periods, in which tripping was done, there were 960 flowers tripped and an equal number of untripped flowers were selected to serve as checks. The foregoing results, when given in the form of percentage, show that 9.48% of the tripped flowers, and 5.94% of the untripped flowers formed seed pods. With such a low percentage of seed pods from the flowers that were tripped, even though it is almost double that from the untripped, it is quite evident that lack of tripping was by no means the limiting factor in bringing about a satisfactory setting of seed. The time of day when tripping was done also does not appear to influence seed-setting appreciably. Practically all of the flowers tripped were fully matured and tripped very readily.

A record was also kept of the color of the flowers under observation. This did not show that flowers of any one particular color had any advantage over flowers of any other color in the formation of seed.

In order to vary the conditions somewh tripping on the third day, July 30th, w done on a different field of alfalfa. Th field which was seeded broadcast, had a pa ticularly poor setting of seed throughout, a this no doubt accounts for the number seed pods formed on that day being so mu lower than that of each of the other thr Tripping in the latter case was done on falfa in hills.

The weather was clear throughout the four days, excepting the first period on t morning of the 31st, when the sky was st somewhat cloudy after a very light rain-fa the previous evening. With the excepti also of the afternoon of the 28th, there w much less wind throughout these four da than is customary in this district. On t afternoon mentioned, the average velocity w nineteen miles per hour, while the avera for the remainder of the four days was a proximately 4.5 miles per hour.

The investigations under discussion are ing continued on a more extensive scale d ing the present year.

: : BOOK REVIEWS : :

THE AGRICULTURAL SITUATION, by G. F. Warren & F. A. Pearson. (John Wiley & Sons, New York, 1924. $3.00).

This volume, which made its appearance in the latter part of last year and has been well advertised by the publishers in the United States, has probably not come to the notice of very many Canadians. It deals with a subject to which everyone should be giving careful attention, and covers it from quite a new and interesting angle.

To business men, farmers and agricultural students alike the depression of the past decade is common knowledge. As to the causes of that depression, the present outlook and possible remedies, information of a dependable nature has been hard to find. *The Agricultural Situation* furnishes very complete data, gathered from reliable sources and presented to the reader in a very comprehensive way.

The book contains somewhat over three hundred pages, divided into twenty-eig chapters, and includes one hundred and t figures and one hundred and fifty tables. anyone who wishes to have a better kno ledge of a common and vital economic pr lem it is invaluable.

The authors are on the staff of Corn University in the Department of Agricultu Economics.

MANUAL OF TREE & SHRUB INSECTS, Ephraim Porter Felt. (Macmillan Compa of Canada, Toronto, 1924, $4.20).

As a popular and practical book, dealin with a phase of entomology which is beco ing increasingly important, this volume is useful addition to available texts. It d not attempt to deal with the subject in technical way, but appears to have been p pared in order to outline and review the sect problem as affecting forest and sha trees, in a manner which will interest t layman. This the author (State Entomo

ist of New York) makes quite plain in his reface.

The book is divided into four parts dealng consecutively with (1) The nature and ransformation of insects, their place in naure, etc., (2) insects attacking shade trees nd ornamental shrubs, (3) forest insects and 4) characteristics and habits of insects afecting trees and shrubs.

Three hundred and eighty-two pages, illustrated.

General Systematic Bacteriology, by R. E. Buchanan (Williams & Wilkins Co., Baltimore, Md., 1925. ($6.00).

Realizing that bacteriologists have long elt the need for a more complete nomenclaure, the author has brought together sufficient material to assist in meeting that conlition. The book is plainly a serious attempt o stabilize bacteriological nomenclature and he author's preface deals briefly with the auses for the confusions and inconsistenies which have arisen. These are more comletely outlined in the first chapter, which resents practically all classifications and eys that have appeared up to the present.

The second chapter deals with codes of omenclature and the third is "An alphabetical list of all the names which have been sed by various authors to designate bacteral subgenera, genera or higher groups so ar as a rather comprehensive study of the iterature has revealed them."

The volume contains six hundred pages, including an extensive bibliography and a complete subject index.

English Pleasure Gardens, by Rose Standish Nichols. (Macmillan Company of Canada, 1925. $3.00).

This is the most enjoyable book that has come to us for review for many months. It is not highly technical in subject matter; it is profusely illustrated with nearly three hundred drawings and photographs; it is printed in large clear type and can be read from beginning to end without effort.

The subject should be of interest to all lovers of outdoor and all students of history. It is a history of the development of classic pleasure gardens, beginning with the old Roman gardens in England and going through numerous successive periods.

Every horticulturist, landscape gardener and lover of nature should have this book. It was first published in 1902, and has been reprinted to meet a new demand. 324 pages.

Inanition and Malnutrition, by C. M. Jackson (Blakiston's Son and Co., Philadelphia, Pa., 1925. $8.00.)

To be reviewed next month.

The Law of Diminishing Returns, by W. J. Spillman and Emil Lang. (World Book Company, Yonkers-on-Hudson, N.Y. $1.80).

To be reviewed next month.

GRADUATE SCHOLARSHIP IN MACDONALD COLLEGE

Dr. Milton Hersey's gift of a graduate Scholarship in Macdonald College has been renewed for the session of 1925-26. The Scholarship is of the amount of four hundred dollars and in its award preference is given to candidates whose intention is to investigate some application of chemistry to agricultural problems.

Advanced courses in agricultural and food chemistry as well as in agronomy, bacteriology, botany, entomology and physics are given in Macdonald College under the Faculty of Graduate Studies and Research of McGill University.

Though not very convenient, it is not impossible for graduate students resident in Macdonald College to take some of the graduate courses in McGill simultaneously with those in Macdonald. The courses offered in Macdonald College are sufficient to qualify candidates for the degree of Master of Science.

Applications for the Scholarship will be received up to May 15th. They should be addressed to Prof. J. F. Snell, Macdonald College, P.Q., and should give full information about the qualifications of the candidate.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

LA COLLABORATION FRANCAISE A LA REVUE AGRONOMIQUE ET SON PROGRAMME.

A maintes reprises au cours des dernières années, et, notamment, à plusieurs réunions des sections de Montréal ou de Québec de la C.S.T.A., la question de la collaboration française à l'organe officiel de l'Association générale des Techniciens agricoles du Dominion a été longuement discutée. Cependant, les faits sont là qui démontrent que la véritable solution du problème n'a pas été trouvée ou appliquée jusqu'ici, puisque, malgré des appels réitérés à la bonne volonté et à l'esprit d'initiative des membres, la collaboration est restée plus qu'intermittente. En effet, ne vit on pas jusqu'à trois ou quatres numéros de la Revue paraitre à la suite les uns des autres sans qu'un seul article français vint occuper une partie de l'espace qui nous est réservé jusqu'à concurrence de six pages.

Est-il besoin de démontrer qu'un tel état de choses est infiniment regrettable, à tous les points de vue? Nous ne le croyons pas, chacun de rendra compte par lui-même, sans qu'il faille insister, qu'il y va de l'honneur professionnel des agronomes canadiens-français considérés comme corps, qu'un changement s'opère au plus tôt si nous ne voulons pas pâtir dans l'opinion publique. Aussi est-il plus utile peut-être de prouver que nous sommes parfaitement à même d'apporter une contribution aussi intéressante qu'honorable à cette Revue, manifestation de l'esprit de coopération, dans la recherche d'un intérêt commun, qui doit exister entre les deux groupes des techniciens agricoles du Canada, du moment que la ferme volonté y sera et qu'on aura fait litière de certaines timidités ayant le tort de paralyser tant de bons mouvements.

Pour cela, examinons tout d'abord quelques-unes des raisons ou prétextes apportés, aux cours de comparaisons peu avantageuses pour nous, lors des discussions du sujet, tendant à expliquer ou à excuser, sinon à justifier une indifférence par trop flagrante à l'égard d'une publication qui devrait être soutenue de tout notre pouvoir.

"Nous ne pouvons nous mesurer avec nos confrères anglo-canadiens," entend-on dire souvent, ils disposent d'une demi-douzaine d'universités ou collèges, échelonnés de l'Atlantique au Pacifique, dont quelques-uns déjà anciens et d'une renommée qui n'est plus à faire, tous parfaitement outillés pour exécuter des travaux de recherche et d'expérimentation. Dans ces institutions, un nombreux personnel, composé de professeurs ayant atteint le plein épanouissement de leur carrière scientifique, aidés, chacun, de tout un groupe d'assistants, peut se livrer à loisir à des travaux originaux, dans les différentes branches de la science agricole, pour lesquels il ne demande pas mieux que de trouver une occasion de publication, tandis que dans nos jeunes écoles d'agriculture, avec leurs laboratoires encore embryonnaires, le corps enseignant, réduit à un minimum, a juste le temps de s'acquitter de ses devoirs pédagogiques, ou cherche, s'il lui reste des loisirs, à augmenter par un peu de travail extérieur les revenus d'un trop modeste traitement."

Ah! certes, si l'on ne veut se placer qu'au point de vue des publications de travaux, de recherche purement scientifique ou d'expériences méthodiques dans les grands collèges ou fermes expérimentales du Dominion, l'avantage en faveur des agronomes de langue anglaise est trop manifeste. Mais, tout d'abord, on peut se demander s'il y a bien de quoi en rougir pour nous? Aucunement, beaucoup moins nombreux, les agronomes franco-canadiens sont aussi beaucoup plus jeunes dans le domaine de la science agricole, ils ne disposent pas, ainsi qu'on vient de le faire

arquer, des mêmes moyens de travail, en
e qu'il serait absolument déraisonnable
iger d'eux des travaux aussi abondants
un même genre de production. D'autre
, il n'est peut-être pas mauvais de rap-
r qu'on a parfois une tendance à abuser
cette locution, quelque peu prétentieuse,
s qui fait si bel effet, de "travail de
ierche original," même lorsqu'il s'agit
ie publication de caractère professionnel
olutot scientifique, tel que l'organe de
sociation de nos techniciens agricoles;
qui se sont donnés la peine d'en suivre
peu la collaboration anglaise auront pu
endre compte, en effet, qu'à côté d'articles
ndant vraiment à la qualification men-
née plus haut, il en est paru un grand
ibre d'autres, fort bons d'ailleurs,
alyse, de compilation ou de condensa-
de sujets généraux de la science agrono-
ue, ou encore des travaux purement
culatifs tels que, par exemple, des con-
rations sur les programmes d'enseigne-
t agricole, sur des problèmes économiques
l'heure présente, etc. Or, voilà déjà une
table mine, difficilement épuisable et tout
iquée aux professeurs de nos deux écoles
riculture françaises, d'abord, ensuite aux
s ou fonctionnaires attachés aux dif-
nts services départementaux des ministères
vincial et fédéral de l'agriculture, ainsi
ux agronomes de district, quoique nous
cédions sans peine que la nature des oc-
ations de ces derniers ne leur laisse pas
ucoup l'occasion ni les loisirs de suivre
revues scientifiques ou d'approfondir les
rages nouveaux parus dans les diverses
nches de la science agronomique. Remar-
ns encore que le bilinguisme nous con-
même certains avantages sur nos con-
yens anglo-canadiens, en un sens, puis-
dans le vaste domaine d'inspiration et de
umentation que représente la littérature
icole mondiale, nous pouvons puiser aux
rces anglaises comme aux françaises, alors
ces dernières sont pratiquement inacces-
es pour eux. Ensuite, si nous voulons
nous placer à un autre point de vue,
a à tenir compte que les agronomes
co-canadiens forment un groupe compact,
ité à la seule province de Québec, dont
les membres se connaissent; ceci nous
net de réserver une partie fort utile de la
aboration à des articles d'intérêt plutôt
local, qui seraient beaucoup moins bienvenus dans la revue anglaise s'adressant à des membres disséminés dans toute l'étendue des neuf provinces de la vaste Confédération canadienne. Et c'est ici que nous faisons un appel spécial à la coopération des agronomes de district, particulièrement désignés pour fournir les communications en rapport avec leurs activités dans les diverses régions de la province de Québec. En effet, ne sommes-nous pas, actuellement, beaucoup trop peu au courant des problèmes généraux et particuliers qu'ils ont à résoudre, chacun dans leur comté, des succès qui ont couronné telle initiative, des difficultés rencontrées dans l'application de telle partie du programme visant à l'amélioration des conditions du cultivateur. Pourquoi ne se serviraient-ils pas de la Revue Agronomique, intermédiaire précieux pour la communication des résultats d'observations fort utiles non seulement à tous leurs collègues de l'agronomat, mais intéressantes encore pour toutes les personnes mêlées aux problèmes agricoles de notre province. De cette manière la Revue deviendra aussi l'agent naturel de liaison entre tous les membres du corps des agronomes considéré dans sa plus large acceptation, c'est-à-dire en y comprenant aussi les professeurs des écoles d'agriculture, les officiers des services départementaux et les diplômés établis pour leur propre compte. De plus, dans le but de donner un caractère plus intime à ces relations qu'il est si désirable de voir s'établir, nous nous proposons d'instituer dans la Revue, outre la rubrique générale portant comme titre "nouvelles de nos membres", sous laquelle il sera fait part des nominations, promotions, changements, évènements heureux ou deuils affectant la grande famille agronomique, des sous-titres spéciaux consacrés:

1o: Aux activités de nos deux Ecoles d'Agriculture, de Ste. Anne de la Pocatière et d'Oka, se portant sur les développements matériels et scientifiques, examens finaux, etc;

2o: Aux activités des sections de Québec et de Montréal de la C.S.T.A., donnant des compte-rendus de leurs réunions mensuelles, des conférences faites à ces occasions, des problèmes discutés, des projets élaborés, des motions proposées, etc. Notre intention est encore de faire suivre la matière ordinaire de notre publication et les rubriques mention-

nées, d'une petite chronique bibliographique où il sera fait une brève analyse et appréciation d'ouvrages récents, de bulletins ou de périodiques ayant trait aux différentes branches de la science agricole et de ses applications. Nul doute qu'il y aura là moyen de rendre service aux lecteurs désireux d'avoir des références sur des sujets qui les intéressent, un jugement sur des livres et brochures susceptibles de leur être utiles.

Enfin, nous avons toujours affirmé dans le passé, que la collaboration à la Revue Agronomique devrait être rémunérée, quelque modestement que ce soit eu égard aux moyens limités dont elle dispose à cet effet. Et nous maintenons cette affirmation, quand bien même quelques-uns pourraient, au premier abord, la juger peu fondée ou puérile pour la raison que celui qui se donne la peine d'écrire un article de quelque valeur méprisera les quelques piastres qui mesurent si mal son travail et sa compétence, aimant autant, si ne préférant pas, le fournir gratuitement afin de briguer le seul honneur de collaborer à une revue sérieuse. Loin de nous de vouloir faire l'injure, à nos honorables collaborateurs, que la faible rétribution que nous sommes en mesure de leur offrir représente le salaire d'un travail de plusieurs heures, la valeur d'une compétence acquise au prix de plusieurs années d'étude; elle ne représente qu'un témoignage d'appréciation pour l'effort donné, témoignage qui se mesure à la bonne volonté qu'y-met la direction responsable. Or, nous savons par expérience que lorsque ce témoignage, quelque minime qu'il soit au point de vue matériel, fait entièrement défaut, les mieux disposés éprouvent facilement l'impression qu'on ne fait guère de cas de leur collaboration et qu'on tient tout juste à les exploiter gratuitement dans le but de remplir un certain nombre de pages. Ne recevant aucun encouragement, ils réserveront leurs activités pour des travaux lucratifs ou pour des publications donnant au moins quelque preuve tangible de l'estime dans laquelle elles tiennent leurs communications. C'est pourquoi il a été décidé d'accorder la même rétribution en cours dans des publications sérieuses et de réputation bien établie, telle que la "Revue Trimestrielle Canadienne", c'est-à-dire deux piastres par page, pour les articles originaux et inédits qui paraîtront dans la "Revue Agronomique".

Nous nous flattons d'avoir, dans ce pe exposé programme, suffisamment démon que la "Revue Agronomique française", édi de concert avec celle de nos confrères langue anglaise, peut vivre, marcher dans voie du progrès et de la prospérité si vo le voulez. Nous disposons là d'une occasi unique, dont la perte par notre faute ser vraiment déplorable, d'affirmer par la plu les aspirations et la valeur du corps agr omique canadien-français.

En avant et confiance donc! Maintenc avec fermeté et courage le drapeau de no jeune phalange jusqu'à ce que la matur professionnelle et l'apport de nouvelles crues de mieux en mieux armées à mesu que se développeront nos moyens d'organi tion et de travail technique agricole no permettent de le lever toujours plus ha pour l'honneur de l'agriculture canadien française.

L'EXTENSION DES ETUDES AGRONOMIQUES

En Hollande, les études pour l'obtenti du diplôme universitaire "d'ingénieur agr ome" sont actuellement portées à cinq anné D'autre part, les exigences pour l'admissi à l'Université agricole de Wageningen so très rigoureuses, il faut avoir fait un cou complet d'humanités classiques ou modern dont le programme fort élaboré compor notamment un entrainement sérieux en mat matiques, en physique et en chimie.

L'ECONOMIE A REALISER

Ce printemps nous eûmes l'occasion de fa une petite enquête avec Monsieur Land agronome officiel du comté de Laval, au su des engrais chimiques achetés par les mar chers, de ce comté, qui commencent à conso mer de fortes quantités de fertilisants co merciaux. Cela nous permit de consta notamment qu'un engrais composé, de formule 2-8-2 s'y vendait couramment prix de $45. et plus à la tonne. En calcula le prix de revient d'un engrais équivale préparé par le mélange de matériaux simpl concentrés, il appert que le coût serait de $1 à la tonne. Le rapprochement des deux ch fres est assez éloquent par lui-même pour qu soit superflu de faire remarquer l'économie faire réaliser aux cultivateurs en leur pr chant le "*home mixing*" ou l'emploi des e grais simples.

Activities de nos Sections.

Section de Québec

Le 17 mars dernier, la section de Québec ait sa réunion annuelle dans les bureaux Service de la Grande Culture, rue Lachevtière. Une trentaine de membres assistaient ette reunion dont plusieurs de la section de ontréal, y compris M. Gustave Toupin, proseur d'industrie animale à l'Institut Agrile d'Oka et secretaire de la section soeur.

Le principal travail de l'assemblée fut le oix d'un comité devant s'occuper de l'érecn d'un monument au professeur Marsan, des pionniers de l'agriculture scientifique ns la Province de Québec, dont la science le dévouement méritent d'être récompensés. comité fut constitué des membres suivants: -A. Rousseau, Léo Brown, Abel Raymond, phonse Désilets, F.-N. Savoie, Elzear Monuil, L.-P. Roy, Antonio Mathieu, Gustave upin, R. Summerby, Adélard Godbout, J.- Descoteaux, M.P., Oscar Lessard, Arsène nis, les Directeurs de nos écoles d'agricultre, le Supérieur du collège de l'Assomptn et le Préfet de ce comté.

L'assemblée ratifia le choix de M. H.-M. gant comme secrétaire français de la Socé, lequel avait déjà été suggéré par les embres de la section de Montréal. M. Nagt devra s'occuper de la rédaction de la rtie française de *la Revue Agronomique*, gane de la Société.

Le Président de la section de Québec ayant missionné, le scrutin désigna M. Roger gnon pour lui succéder. Les autres ofiers ayant été réelus, l'executif se compose aintenant comme suit:

President: Roger Gagnon.

Vice-Président: Adélard Godbout.

Secrétaire-Trésorier: Omer Caron.

Comme on le sait, la Société des Ingénurs Agricoles groupe tous les bacheliers en riculture. Environ 750 membres en font rtie dont 123 dans les deux sections franises.

O. C.

Section de Montréal

Il n'y a pas de doute que si M. Gustave Toupin, l'ardent secrétaire de la section de Montréal, eut montré le même entrain à la rédaction des rapports qu'à l'organisation de ses réunions, nous aurions eu plus d'une communication intéressante au sujet des activités de ce groupe, depuis une couple d'années. En attendant une réplique à l'innocent caillou lancé dans la mare, force sera donc de nous contenter d'un bref compte rendu capable de donner une idée générale de l'oeuvre accomplie.

On se rappellera qu'au printemps de l'année 1923, il fut décidé de tenir, chaque mois, à Montréal, une réunion d'agronomes, sous forme de diner causerie au cours duquel une conférence, sur un sujet intéressant l'agriculture, serait faite, soit par un membre de l'association, soit par une autorité choisie en dehors. Aujourd'hui, il nous est permis d'affirmer, sans exagération aucune, que, grâce au concours des circonstances favorables, le projet a été réalisé bien au delà des espérances caressées.

Tout d'abord, il nous tarde d'adresser un hommage de sincère reconnaissance aux autorités du Cercle Universitaire de Montréal, qui, avec la plus charmante bonne grâce, ont mis à la disposition des agronomes les salons et la salle de restaurant de leur hôtel de la rue St-Hubert, pour ces agapes fraternelles. C'est donc à ce foyer hospitalier que, depuis plus de deux ans, nos confrères en agronomie peuvent se retrouver chaque mois autour de petites tables bien servies, s'abandonner au plaisir de la conversation entre amis intéressés aux mêmes sujets, et à l'effet émoustillant d'un verre de généreux vin de France, capable de les mettre tout juste au diapason voulu pour écouter dans des dispositions idéales les savants développements des doctes conférenciers venant ajouter un digne couronnement au dessert et au café. Au cours d'unpremier diner, au mois d'avril 1923, M. H.-M. Nagant exposa l'object de ces réunions, qui, outre la création de relations plus intimes entre membres d'une même profession, visent à l'établissement de contacts, profit-

ables pour tous, avec les milieux sociaux, les milieux universitaires et plus particulièrement, peut on dire, avec la faculté des Sciences, de l'Université de Montréal, dont les affinités avec la science agronomique sont si naturelles.

Ce fut le Dr. Charron, directeur du laboratoire provincial et de l'Ecole de laiterie de St-Hyacinthe qui ouvrit la série régulière des diners-causerie, au mois de mai suivant, par une relation de son voyage en Europe où il avait représenté officiellement de département d'agriculture d'Ottawa, à une assemblée générale de l'Institut International d'Agriculture de Rome.

Nous ne ferons qu'énumérer, dans l'ordre de succession, les distingués conférenciers qui, dans la suite, furent présentés aux auditeurs par le président de la section de Montréal et apportèrent leur précieux concours à la réussite et à l'action féconde de ces réunions. Au mois de décembre 1923, on eut l'avantage d'écouter le Révérend Frère M. Victorin, professeur de botanique à l'université de Montréal, exposer les théories de l'hérédité; en février 1924, ce fut le professeur Barton, du collège Macdonald, président général de la C.S.T.A. qui vint parler des débouchés nouveaux à envisager pour les gradués en agriculture; monsieur Henri Bois, professeur d'Economie rurale à l'Institut Agricole d'Oka, en mars, nous entretint de l'importance d'un service d'Economie rurale, tandis que le mois suivant ce fut le tour de monsieur Charles Fontaine, professeur de Technologie des sols à la même Ecole, de faire ressortir tout l'intérêt que présente l'étude du sol; enfin, la série, pour l'année académique, 1923-24 fut close par une brillante conférence sur la Biologie du sol, faite par le Dr. Dalbis, professeur de biologie à l'Université de Montréal.

Reprise en novembre 1924, on entendit tout à tour, MM. H.-M. Nagant, qui fit lerécit d'une visite aux mines de potasse d'Alsace, monsieur Gustave Toupin parlant du programme d'action des agronomes, et en dernier lieu, au mois de février 1925, M. Jules Simard, Inspecteur de District à la Division des Semences d'Ottawa, qui nous donna un substantiel exposé de l'organisation de ce service dans la province de Québec.

Nous nous en voudrions de ne pas ajo à la liste des conférenciers celle de quelq uns de nos hôtes d'honneur qui par leur sence et leur éloquente parole ajoutè grandement au charme de ces réunions. ordre successif toujours, mentionnons l P. Léopold Directeur de l'Institut Agri d'Oka, M. Edouard Montpetit, secrétaire éral de l'Université de Montréal, le Baril, professeur de chimie organique Faculté des Sciences de l'Université, compter plusieurs de nos excellents ami la section de Québec, et M. Fred. H. Grin le dévoué secrétaire générale de la C.S.T qui à l'occasion nous firent le grand pl de partager nos petits banquets.

Par ce exposé fort succinct, nous espé en avoir dit assez cependant pour démon que la section de Montréal fait oeuvre autant qu'agréable au moyen de ses di causerie.

C'est avec satisfaction aussi que nous fitons de l'occasion pour adresser un sin merci à ceux des membres qui par leur fi présence ont tant contribué au succès réunions qui groupèrent jusqu'à 35 audite

En même temps, nous lançons une cordiale et pressante invitation à d'autres pourraient en faire autant, mais qui n'y peut-être pas songé jusqu'ici, ainsi qu'à nouvellement entrès dans la C.S.T.A. leur coopération dépend le maintien et le grès d'une initiative intéressante bien pr à entretenir la vitalité de notre associatio

Il va sans dire aussi qu'une invitation érale e chaleureuse s'adresse à nos amis Québec et des sections anglaises, chaque qu'ils auraient l'occasion d'être des nôtr ces assises d'agronomes.

H. M

NOUVELLES DE NOS MEMBRES

Nous apprenons le mariage de mons P.-H. Vézina, professeur de grande cultu l'Institut Agricole d'Oka, avec Melle E ienne Lefebvre. Après la cérémonie, n confrère est retourné passer sa lune de dans le beau décor de la nature environ le lac Cayuga, où il poursuit des études l'obtention d'un grade à l'Université Cor

C. S. T. A. Forum

This section has been introduced in *Scientific Agriculture* in order to publish communications from C.S.T.A. members dealing with matters of professional interest, and also for the publication of subsequent discussion of such matters. It is hoped that members will take full advantage of the opportunity thus offered of bringing their views to the attention of the profession, and in this way promoting interesting and helpful discussion. The names of correspondents will be omitted if desired, but must always be furnished to the General Secretary.

HOME RULE FOR FARMERS

The serious efforts of the C.S.T.A., have been directed towards cooperation and coordination among professional agriculturists. Overlapping departments, duplication of research and personal jealousy resulted in wasted effort and useless expenditure. The professionals did not practice the cooperation that they preached to farmers. However, exchange of thought and friendly intercourse have had their inevitable effect—broader visions, strengthened goodwill, increased toleration of other views and the serious realization that each member is a unit of that corps mobilized for the solution of the agricultural problem. Instead of individuals working independently, or by departments, regardless of fellow departments, in much the same fashion as artillery demolishing wire without cohesion or the cooperation of other arms, there is a demand for an effective unity of control.

The professional agriculturists have been appointed to their respective positions for the ultimate purpose of assisting farmers upon some particular problem. Their apparatus, technique and administration are not the end-all but merely the means to the end—the improvement of rural life. But, although the first farmers are actually the men and women most interested, have they any opportunity to declare how their own conditions can be improved? It is true that deputations may petition the Cabinet, associations may pass resolutions, ad infinitum, and individuals may appeal to the press, but there is not a systematic channel of thought from farmer to administrator. Under these circumstances it is not surprising that contact is restricted to the short course, convention or commission—the latter is abundant proof that something is wrong. And yet farmers have the right to a fixed voice in agricultural policies such as tariffs, rural credit, education, freight rates, immigration, production, merchandizing, marketing and research. But everyone else seems to have more influence. Doubtless this is in part due to the farmers' indifference; also to the absence of any organization from which advice can be readily procured; and further because no one has cared for the farmers' viewpoint.

Unfortunately many of the foregoing questions have been relegated to party politics, but in so far as the Departments of Agriculture and Education are concerned, has not professionalism rested solely upon its own appreciation of the situation? In doing so, has not contact been lost? Is there not, moreover, a danger that the professionals may develop a psychology consequent upon their actual removal from the soil to the laboratory that, willy nilly, will prevent that true sympathy with the farmers' view point? And, *a fortiori*, are not farmers with their psychology built from generations of isolation, prejudice and conservatism, only too prone to slur over the investigator's difficulties and value with the unjust retort of "a white collar job."

Why have college attendances decreased? Why have short courses lost popularity? Why is there a lack of confidence among many farmers? Why does not every farmer practice proven modern principles? Professional agriculturists and farmers have somehow lost touch. They represent two allied armies combatting a common foe but without the essential unity of command. Professionals have told us repeatedly that they have "showed" the farmers the value of improved methods, and all honor to the painstaking research worker and administrator! But "showing" is not sufficient. The farmer's practice is not keeping pace with science or business. What is behind his mental reservation? Is it prejudice, ignorance or a false pride? The winning of every farmer's confidence is the professional's problem now, not alone production or marketing. Can they stimulate by some inoculation of a general spiritual purpose?

The agricultural problem is essentially an educational and psychological one. It will only be through improved educational facilities, based on citizenship and adapted to rural needs, that farmers will awaken to the full realization of their economic handicaps and counteract them. Then social and moral questions will adjust themselves automatically. But in the meantime can we not set about to replace that rural indifference with a healthy *esprit de corps* based on self-help? It seems to me that the principle of self-help has been neglected in the past, and, moreover, that government assistance has been too paternalistic in that frequently initiative has not been encouraged. When farmers realize that they are masters of their own destiny rather than victims of an overpowering situation, then the present day unconcern, individualism and fatalism will change to optimism and self-assurance. Industrial diseases have given rise to Workers' Parliaments and Whitley Councils with remarkable results. Why should not some similar plan be applicable to farmers?

National coordination is the tendency. As examples, there are the National Councils for Dairy and Horticulture, and the Canadian Council of Agriculture. Wheat pools have had a remarkable growth and now we have the projected Fruit, Vegetable and Dairy Export Committees. But these are busine organizations of specialist farmers seeking sell to better advantage. Why not a nation organization to sell confidence and assuran to farmers? To that end, the essential mo is a general application of a scheme simil to the County Boards of Agriculture or t Advisory Agricultural Councils of Ontar or the Farm Bureaus of the United States strictly non-sectarian and non-political. T county boards could be united under a pro incial organization and a federal coun could further coordinate provincial policie Then the farmers will actually have taken step towards economic emancipation becau they will have gained the spirit of self-help of "home rule" in effect. And each farm will realize his serious responsibility to t success of his profession. Then agricultu will have that spiritual motivating forc Naturally, this will take years to develop b accomplished it can be.

However, at present we have a society co posed of both farmers and professionals—a ideal association for the fostering of this c operation of thought. But nothing in pa ticular is being done to amalgamate the diverse elements. We, as farmers, desire closer association because the latter represe departments and governments, in fact, th are the departments; and it is good for to learn of administrative difficulties and su cesses. And, on the other hand, I have be assured by professionals that they desire similar intimacy with farmers. Hence, gre er encouragement should be extended to e roll every available farmer graduate. As start, I suggest the appointment of a defin standing committee of farmer members on to recommend to the other committees and advise on particular questions referred them. Also there should be at least o farmer upon the standing committees of Ag cultural and Educational Policies, Marketi Education, Graduate Study, Membership a Research. Excellent results have been tained by the active cooperation among p fessionals—greater than was ever expecte it is certain that equally good results, or b ter, would ensue from the closer associati of professionals and farmers.

C. A. GOOD,
R.R. 1, Laurencetown, N

Concerning the C.S.T.A.

In order to publish a very fine piece of search work, we have devoted twenty-four ges of this issue to Dr. Harrington's ticle which appears on page 265.

We consider that this article is highly eritorious and although it is not of direct terest to all C.S.T.A. members, it is one hich, while bringing credit to the author, ll also bring credit to the magazine and the Society.

The section devoted to news of members d branches, topics of special interest to embers and the Forum, have been con-nued and more than the usual amount of ace devoted to book reviews. Such mat-ial appears to be in demand, and an effort being made to develop these and similar atures in order that all members will feel at they have, in their official organ, a med-m through which their professional and rsonal contacts may be maintained.

The re-appearance of a French section ill be appreciated by the members of the ontreal and Quebec branches particularly. has been missing from the magazine too ng and it is to be hoped that Professor agant, the French Editor, will be given the pport and encouragement to which he is titled and that the French section of the agazine will now continue without further pses.

Several excellent articles may be expected the June issue, and if the General Secre-ry survives the usual pre-Convention tor-do, which extends throughout the month May, the issue will also contain those sec-ns for which he is directly responsible.

Plans for the Convention are developing a most satisfactory manner, and the offi-al programme will be mailed to all mem-rs about the end of May. In addition to e regular business sessions, a series of ne advanced lectures is being arranged, d a number of social functions. The ar-ngement of the entire programme is in the nds of Prof. J. P. Sackville of the Univer-ty of Alberta.

Dean E. A. Howes of the University of Alberta, has been elected President of the Society for the coming year and will preside at the Edmonton Convention. This is the first western President since the retirement of President Klinck in June, 1922. Dean Howes has always been an enthusiastic member of the Society and has attended every Annual Convention since its organization. He

E. A. Howes
President-elect.

was chairman of the Organizing Committee in Alberta during the winter of 1919-20 and was Vice-President of the Society during the year 1923-24. The Society will again be in good hands under his direction.

The names of the two vice-presidents are not yet available, as ballots have not been opened. Dean Howes was elected by acclamation.

One cannot imagine the C.S.T.A. without Professor Barton as a member of its Executive Committee, and when he delivers his Presidential address at Edmonton and hands over the reins of office to Dean Howes, he ends five years of splendid service. From 1920 until 1923 he was Vice-President of the Society, and during that period was obliged to assume practically all responsibility during several crises—financial and otherwise—through which the organization passed. Since June, 1923, he has been President.

H. BARTON
Retiring President

No one is in a better position to appreciate all that Professor Barton has done than the writer. We have had innumerable "sessions" together, some of them gloomy, some of them quite the reverse. It is a happy association to look back upon. But how many members can know what it has involved?

Devotion to any cause does not anticipate any tribute, and does not expect any reward. But the writer knows, from personal contact with Professor Barton during a period of five years, that he has given devoted service to an organization in which he has always had faith. His faith will continue, and the service, when called for, will still be given. The accomplishments of the C.S.T.A. during the past five years are about all the reward that the retiring President expects.

Local Secretaries are again reminded to send in the names of their new officers, delegates and Dominion Executive representative, before May 15th. The latter must be a member of the local executive.

The attendance from Ottawa at the Edmonton Convention promises to be very gratifying, as the following have already signified their intention of being present: G. H. Clark, F. H. Grindley, E. S. Hopkins, W. T. Macoun, A. A. MacMillan, G. P. McRostie, L. H. Newman, G. B. Rothwell, F. T. Shutt and P. Stewart.

The social functions so far arranged for the Convention, include banquets by the Alberta Government and the University of Alberta, a live stock demonstration under t direction of J. P. Sackville, an afternoon ception by the Lieutenant-Governor, a tea the wives of the Agricultural Faculty of t University of Alberta, a motor trip to t Prince of Wales' ranch, and a smoker. Tl assortment of "relaxation periods" should e sure concentration to business during busin sessions.

The Executive of the Western Ontario cal is, according to report, arranging a mo trip from Toronto and Guelph, converging Grimsby, and covering the Niagara Peninsu The date is May 23rd, when it is expect that the peach orchards will be in full bloo

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The Eastern Ontario local closed its ye with the Annual Meeting on April 24th. A. MacMillan was elected President for t coming year and "Pat" Stewart Secreta The local has had an excellent year, has members and is solvent.

The annual meeting of the Montreal lo is likely to be held on May 9th—in Montre It is always an enthusiastic gathering.

The C.S.T.A. has sold text-books to t value of $1,000 during the past winter, allo ing members 20 per cent discount on l prices. This service is evidently appreciat and will probably be extended.

Members whose $6.00 fees for the curre year have not yet been paid are urged to se them at once to their local Secretary, or t General Secretary. This is the sort of e couragement that will make it more possi to effect a reduction to $5.00 next year.

A month or two ago we reported that G. Hay had been appointed Live Stock Comm sioner for British Columbia. The report h not been confirmed and we now understa that Mr. Hay is still at Kamloops as D trict Agriculturist.

Dr. C. E. Saunders addressed the East Ontario local at its last luncheon early April. We are glad to have him back Canada again and hope his health will ste ily improve.

Preliminary Studies in Forage Crop Improvement.*

WM. SOUTHWORTH

Manitoba Agricultural College, Winnipeg, Man.

When considered from a general point of iew agricultural practice in the Prairie rovinces may be regarded as being in a tate of transition from grain growing to the aising of livestock and a general trend to- ards mixed farming.

In mixed farming one of the first consid- rations is feed for livestock. As the success f animal husbandry necessarily depends irectly upon the successful production of orage, any work intended to further the in- reased production and general improvement f forage crops must be designed with a view o the needs of the livestock for which it is ntended; hence, the necessity for close co- peration between the improver of forage rops and the livestock farmer cannot be too trongly emphasized.

In a new country the principal supply of orage naturally comes from native pasture nd wild hay. When the land is brought un- er cultivation and the stage is reached when ixed farming is coming into practice, the armer looks round for the kind of plant or lants which will best serve his purpose to roduce forage for his stock. This is not sually an easy task. He may first of all ather seeds from wild plants or import seeds f crops which have been used with success in ther countries. In course of time by repeat- d trials and failures he may succeed in find- ng certain crops which are more or less suit- d to meet his requirements.

At first sight one might reasonably sup- ose that the native plants would be those ost likely to suit his purpose. Experience as shown however that while most native lants appear to be well suited to their nat- ral habitat in the wild state, they usually fail ither wholly or in part when brought under he changed conditions imposed by cultiva- ion.

After testing out several species of native rasses at the Manitoba Agricultural College, e have up to the present only found two hich seem to be at all promising under cul- tivation; and as yet we are not at all sure that these will be able to compete successfully with well-known tame grasses now commonly used in farm practice.

It is a remarkable fact that so far Western Rye Grass seems to be the only native western grass found which is capable of standing up successfully under a system of continuous cultivation.

If we consider briefly the qualities which a forage plant should possess before it may be classed as a plant suitable for cultivation, we shall find the requirements are so exacting that comparatively few plants can fulfill many of them.

For successful crop production plants are required which will produce a crop of high class fodder over a given area at a minimum cost of production. To accomplish this, it will be readily seen that we must have plants which are both nutritive and palatable and have a high productive capacity. They must be adapted to the soil and climate, be good seed producers, hardy, easily handled on the farm, and not too exhaustive of moisture and soil fertility.

The question of adaptability of a forage crop to the environment in which it is to be grown, is one of outstanding importance and should be closely studied. By good cultivation and judicious manuring, it is possible to influence to some extent the character of the soil, but we have no power to change the climate; therefore, our first consideration is to find plants which will be well adapted to the peculiarities of our climate and other environmental influences.

In casting about for suitable forage plants for trial in a new country, it is natural that we should look to those crops which have been grown successfully in the older countries of the world.

If we keep in mind local weather conditions and study the crops grown in the older coun-

*Paper read before the Western Canadian Society of Agronomy, December, 1924.

tries, and especially those which have a similar climate to our own, it is likely that at least some of these crops will prove to be suitable for our purposes. Such studies as these are exceedingly valuable but the information gained should always be used cautiously and in conjunction with an all round acquaintance of the possibilities and requirements of the crops under consideration. Placing too much reliance on weather records may lead us to become very much restricted in our choice of crops, and one may be so influenced by weather records as to overlook certain crops, which, if properly tested, might eventually prove to be adaptable to our special conditions.

For example, if we were to be guided solely by weather records, such plants as corn, Sudan Grass, sorghum and soybeans would be classed as crops being quite unsuited for profitable production of fodder in Manitoba. The only safe guides as to whether a particular crop will be adapted to certain soil and climatic conditions are the results of properly designed and carefully conducted field tests continued over a series of years. Also there is the possibility of taking in hand certain crops which may not be considered uniformly well adapted to our conditions but do lend themselves to the selection and development of acclimatized strains which may in course of time prove to be of great agricultural value.

It would seem then that the primary duties of the improver of forage crops is to find out by actual trials in the field which forage crops are most likely to serve the purpose of the livestock farmer in the district in which he is working.

When making selections of plants for these preliminary trial plots, great care should be exercised in the choice of plants, and the person undertaking such work should have had a wide experience in the actual growth of forage plants, as well as a broad knowledge of how the leading forage plants behave in various parts of the world. He should also make full use of all the local knowledge which may be available.

In searching the plant kingdom for plants suitable for forage, we find that the vast majority belong to two groups or families—the Grass family or *Graminaceae* and the Clover family or *Leguminosae*. Of the gramineous plants which are sometimes termed true gras ses, there are only a very few species whic seem to be profitable for cultivation for for age. In annual gramineous plants there ar the small grain cereals, together with corn millets, sorghums, each containing man varieties more or less adapted for produc tion for forage under varied conditions o soil and climate. In the group of perennia and biennial leguminous fodder crops com paratively few are extensively cultivated, th most widely known being alfalfa, red clover white clover, alsike and sweet clover In the group of annuals we have many var ieties of peas, beans, vetches and some annua clovers, which are largely restricted to coun tries having climatic conditions speciall suited to this class of crop.

During the past nine or ten years effort have been put forth at the Manitoba Agricul tural College in an attempt to find out which grasses and leguminous forage crops are mos successful for crop production in Manitoba With this object in view, a series of row plot were sown down by Professor T. J. Harrison i 1915, with twenty-three species of grasses These were made up of four species of poa five fescues, two loliums, two oat grasses, tw bromes, two agrostis and one each of Tim othy, Western Rye Grass, Orchard Grass Meadow Foxtail, Sweet Vernal, Crested Dogs tail. All of these grasses, with the exceptio of western rye grass, have been introduced t this continent from the old world.

To discuss the behaviour of each differen grass would carry us far beyond the scope o this paper; we may however say briefly tha some of them did not survive the first winte and after the second winter many more wer either entirely killed out or greatly weakene and did not recover.

After the fourth winter, out of the twenty three species under test, only seven remaine which seemed to have come through the fou years' test in a satisfactory manner; the were—awnless brome grass, western ry grass, meadow fescue, Timothy, Red Top Kentucky Blue Grass and Canada Blue Grass For hay production the first four gave th most promise, the last three being apparentl better suited for pasture.

In addition to the small test plots of var ieties of grasses, thirty-one larger plots wer

ded down with four of the principal leg-
nes—alfalfa, red clover, alsike and sweet
over; these were sown alone and also in
njunction with certain grasses.

The general conclusions drawn from these
eliminary trials tended to confirm the opin-
n that for quality and yield, alfalfa was
cidedly the outstanding legume forage plant
r Manitoba. The yield of alfalfa being
preciably greater than that obtained from
y of the other legumes or grasses, it was
nsidered advisable to spend the major por-
on of our energies in the improvement of
falfa, leaving the lesser important legumes
d the grasses to a somewhat less intensive
udy.

In beginning with alfalfa improvement, 21
lections were planted with seed from the
A. C. Department of Field Husbandry,
uelph. Of these, eleven were selections from
mans Excelsior Grimm and the remaining
n from sand Lucerne, first introduced by
e United States Department of Agriculture.
ne seed from these selections was planted by
nd in hills, 210 hills to each selection mak-
g a total of 4,410 hills, the plants being
ngled out to one at each hill.

The crop came through the first winter of
916-17 in first class condition, very few
ants being killed out. The winter of 1917-18 however, owing to the scanty covering of snow, was very severe on alfalfa. In 5 Grimm selections over 90% of the plants winter killed and in 7 selections of sand Lucerne over 90% failed to withstand the trying winter. One of the selections in this group was a promising seed producer but not a single plant of this crop survived.

Of the 21 selections planted, it was found that after the winter of 1917-18, there were in all only seven selections that seemed to contain sufficient living plants to warrant giving them a further trial. See fig. I.

From the best of the hardy plants which survived the winter of 1917-18, seed was saved for further tests in row plots. These plots were sown down in 1919 and so far one Grimm strain and two strains of sand Lucerne are giving very promising results. All three have passed successfully through five winters and each year they have yielded good crops of forage with a moderate amount of seed.

It might perhaps not be out of place to mention some of the anomalous results which may appear in the attempt to improve alfalfa. We may consider, for example, the question of hardiness. Hardiness or resistance to winter killing is a quality which can be studied in a very definite fashion in the field. Carefully conducted tests with individual plants

Fig. 1. Plot of 21 selections of Alfalfa in spring of 1918. In the fall of 1917 the average stand of the 21 selections was 97 per cent perfect.

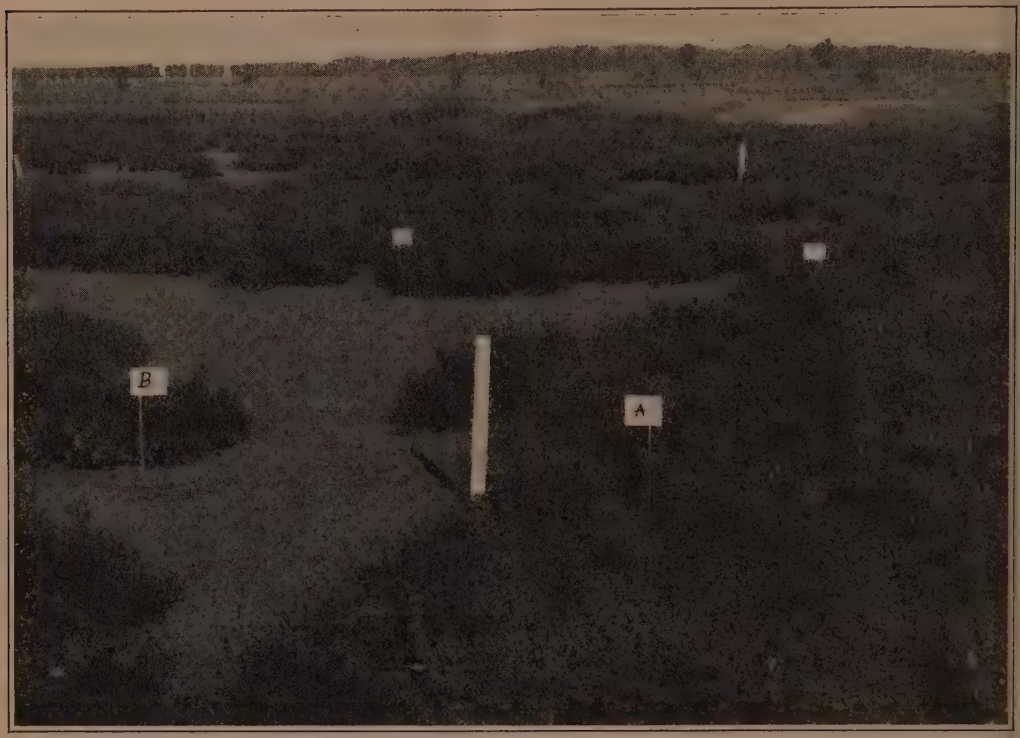


Fig. 2. Plot A: Grimm Alfalfa selection L2-3. A hardy strain 31 per cent winter killed 1916-17-18.
Plot B: Selection L2-3-3 progeny of L2-3. A tender strain 87 per cent winter killed 1916-17-18.

raised from Lymans Excelsior Grimm alfalfa gave results as recorded in the following table:

Mother Plant	Per cent of plants killed in progeny after two winters 1916-17-18
(a) L2 – 3	31 per cent
(b) L2–3–3	87 " "
(c) L2–3–6	87 " "
(d) L2–3–21	96 " "
(e) L2–3–40	87 " "

From the above it is seen that the progeny of the first selection L2-3 is fairly hardy while that of the four selections b, c, d, e, descended from L2–3 are all decidedly inferior to the mother plant in resistance to winter killing (see fig. 2).

Another example from sand Lucerne will show that a fairly hardy strain may segregate from a decidedly tender parent.

Mother Plant	Per cent of plants killed in progeny after two winters 1916-17-18
(a) L3–13	94 per cent
(b) L3–13–15	80 " "
(c) L3–20–18	45 " "

The above examples serve to show that we are to make any advance in the improv ment of our open-fertilized crops, such alfalfa, great care must be exercised in ma ing selections and checking up results, an repeated selections will usually be necessa so as to run down a strain which reproduc true to hardiness.

Seed Production.

In dealing with seed production in alfalf we find a much more difficult and elusi problem than that of hardiness. As an e ample of the variation in seed productio the results from a single plant are given f a period of seven crops of seed.

	Weight of Seed in Grams
Seed sown in 1916	00.0
1917	175.4
1918	28.6
1919	56.8
1920	129.4
1921	36.6
1922	64.6
1923	17.0

These results seem to indicate that the seeding capacity of a plant may fluctuate greatly from year to year and that the inherent tendency of a plant to produce seed may somehow be influenced either by weather conditions or plant nutrients or some internal physiological change in the plant restricting abundant seed production.

It is encouraging to know that bio-chemists and plant physiologists are already engaged in investigating the relation of plant nutrition to seed formation, and plant breeders together with agronomists and horticulturists are looking forward with great interest and hope that these investigations may ultimately throw some light on this important problem.

The Amount of Variability which May be Expected to Occur in a Determination of Comparative Yields in Small Grains.*

W. T. WIENER and R. BROADFOOT

We have often been surprised at the marked divergence in yield from two similarly treated wheat plots. This divergence of yield is to be expected when the variable physical and chemical composition of the most uniform appearing soil is considered. The difficulties of making all conditions of similar nature for a large number of varieties and strains which must be tested are very numerous. The method used must be such that the performance will be a correct indication of the comparative value of the strains tested when grown under farm conditions.

To determine the validity of the data which we have obtained from plot tests, and if possible to improve our methods, a series of field plot technique experiments were commenced in 1924.

In presenting this paper we realize that it is only a tentative report on a part of the work under way It is not our intention to argue for the acceptance of the least squares method of determining possible errors which may occur in the yields obtained from varying numbers of plots, but rather to show the degree of variability that may be expected to occur between single plots when a large number are given similar treatment and sown to the same variety.

MATERIAL AND METHODS

SEEDING—In the spring of 1924, one range of the variety testing field No. 10 was sown to Mindum durum wheat. The rate of seeding was two bushels per acre, and the seeding was done with an ordinary grain drill. The plots were planned and seeded in the manner used in testing varieties.

SIZE OF PLOT—Each plot as sown consisted of 16 six-inch drill rows and covered an area 8 feet wide by 80 feet long. All plots were trimmed to a length of 72.6 feet about six weeks after the date of emergence. The alley way between the plots was 2 feet wide, with 20 foot roadways between the ranges of plots.

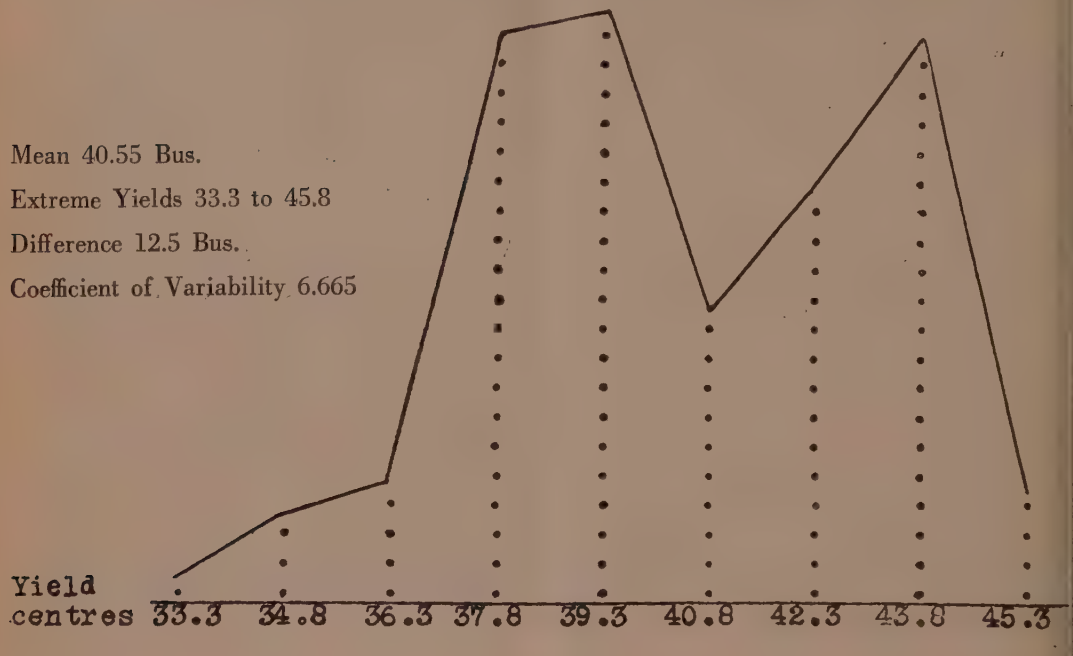
HARVESTING—At harvest time the two outside drill rows on either side of each plot were harvested separately. The size of the harvested plots, after removal of the borders, was 6 feet wide by 72.6 feet long or approximately 1/100 of an acre. No account was taken of the end borders. The threshing was completed with the ordinary plot thresher and yields computed on the basis of the grain coming from the machine. Altogether 94 plots were treated in this manner. The variations in yields obtained from the 94 plots of Mindum wheat are for convenience shown by the frequency curve Fig. 1.

The mean yield obtained from the 94 plots of Mindum distributed in the probability curve shown in Fig. 1 is 40.55 bushels. The lowest yielding plot produced 33.3 bushels, the highest 45.8 bushels, the difference being

*Presented by W. T. G. Wiener before the Annual Convention of the Western Canadian Society of Agronomy, at Winnipeg, Man. Dec. 1924.

FIG. I.

Distribution of Yields from 94 Plots of Mindum Wheat.


Mean 40.55 Bus.
Extreme Yields 33.3 to 45.8
Difference 12.5 Bus.
Coefficient of Variability 6.665
Yield centres 33.3 34.8 36.3 37.8 39.3 40.8 42.3 43.8 45.3
Frequencies 1 3 4 19 20 10 14 19 4

12.5 bushels between least and greatest yielding 1/100 acre plots given identical treatment. The soil under experiment in this instance is not exceptional in that a careful analysis has shown other apparently uniform areas to be equally variable.

It will be noted that the curve in Fig. 1 is bimodal indicating that the soil falls into two natural divisions of productivity, each of which tended to give yields of a different magnitude. It might be argued that such a conclusion is unwarranted in view of the relatively small number of yields (94) plotted in the curve. Inspection of the yield data obtained from the 94 plots of Mindum wheat lead to the belief that there was some tendency to soil patchiness. There also appeared to be an increase in the yields from the plots as they progressed northward along the range.

In order to determine whether these conditions did exist and to what degree, the yields from the 94-1/100 acre plots of Mindum wheat shown in Fig. 1, were arranged in groups of ten, and the mean yield of each group determined. The plots making up each group were taken in progressive order from south to north. Each group yield is, therefore, the average of 10 adjacent 1/100 acre plots. The results are summarized in Table No. 1.

It is apparent that the yields from the 1/100 acre plots making up some of the groups are quite variable, as for instance, those of Group 2, while those of Groups 4, 5 and 8 tend to yield alike. The range of variability is comparatively low, the difference between greatest and least yielding plots being 2.5, 3.34 and 2.5 bushels respectively. The average yield from groups 3, 5, 6, 7, 8 and 9 is less than that of group 4, but all tend to yield more than groups 1 and 2. Thus, the first two groups (20 plots) in the range yield less than the remaining 7 groups (70 plots). The yield of the groups increases as they progress along the range northward. group 4 giving the highest mean yield, and group 1 the lowest.

By showing the distribution and frequency of the 1/100 acre plot yields used in determining each group yield, and then sum-

TABLE NO. 1.

The Mean Yields obtained from 9 Groups consisting of 10 adjacent 1/100 Plots of Mindum Wheat showing a tendency for the yield to increase as the plots progress northward along the range.

South	Group arrangement of Plots	Group No.	Mean Yield of groups of 10-1/100 acre Plots in Bus.	Extremes of Yields of Plots in each group in Bus. per acre	Difference in bushels between extreme yields
	1 to 10	1	37.75	33.30 to 40	6.7
	11 to 20	2	38.46	34.16 to 41.16	7.0
	21 to 30	3	39.96	37.67 to 42.92	5.25
to	31 to 40	4	44.20	43.33 to 45.83	2.50
	41 to 50	5	39.42	38.33 to 41.67	3.34
	51 to 60	6	40.42	37.50 to 44.16	6.66
	61 to 70	7	42.42	38.33 to 44.16	5.83
	71 to 80	8	41.79	40.83 to 43.33	2.50
North	81 to 90	9	39.58	36.67 to 43.33	6.33
	91 to 94	A	42.50		

FIGURE 2.—Distribution of the 1/100 acre plot yields used in determining each group yield and the summation of the results obtained.

Plots	Group No.									
1-10	1	1	1		6	2				
11-20	2		2	2	1	3	1	1		
21-30	3				4	3		3		
31-40	4							1	5	4
41-50	5				2	7	1			
51-60	6				4		2	2	2	
61-70	7				1	1	1	1	6	
71-80	8						3	5	2	
81-90	9			2	1	3	2		2	
91-94	A odd 4 plots					1		1	2	
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Yield centres bus.		33.3	34.8	36.3	37.8	39.3	40.8	42.3	43.8	45.3
Frequencies		1	3	4	19	20	10	14	19	4

ming the results obtained we get a clearer picture of the actual productive possibilities of the various sections of the soil area under consideration. Figure 2 shows the result of such a distribution of yield frequencies.

The land under study happens to include one range of plots extending across the experimental field. It is therefore 72.6 feet wide by 940 feet long. If this area is divided into plots of 1/100, 1/50 and 1/40 acre for the purpose of obtaining comparative yields, it would be sufficient to permit of the testing of the numbers of varieties shown in Table 2.

TABLE No. 2.

Number of varieties which could be tested	Number of systematically distributed plots	Size of plot
94	1	1/100 acre
58	1	1/50 "
50	1	1/40 "
47	2	1/100 "
29	2	1/50 "
25	2	1/40 "
23	4	1/100 "
19	3	1/50 "
16	3	1/40 "

When it is considered that this soil area might in any one season include the entire number of plots allocated to the final testing of wheat varieties, the significance of the variability noted in Fig. 2 at once becomes apparent. Had it been sown to 94 different varieties of wheat instead of the single variety Mindum, the actual productive response of the soil could easily be responsible for a difference of 12.5 bushels between two varieties, which in reality were of equal merit. The error may be even greater. Suppose two varieties differ in yielding ability and the high-yielding sort falls on a plot producing above the average, while the low yielding one falls on the least productive plot of the series, the apparent difference between the two varieties becomes greatly magnified in terms of bushels, because the inherent yield difference plus the variability due to soil are both operating in favor of the greatest yielding sort.

THE VALUE OF REPLICATION

Referring again to the data represented in Fig. 2, and without going into any lengthy discussion, it will take but a minute to point out some of the values of replication.

If the comparative yields of varieties under test are to be taken from the average of replicated plots, it is immediately apparent that the range of variability will narrow down.

The mean yield of a single variety so obtained will result from the combining of any two values ranging between 33.3 and 45.3 bushels. In other words, the plot yielding 33.3 bushels has a chance of being averaged with a replicate tending to yield 34.8, 36.3, 37.8, 40.8, 42.3, 43.8 and 45.3 bushels. Consequently, as a plot yielding 33.3 bushels occurs only once, it would be impossible to obtain a yield as low as this from the use of duplicate plots. Similarly only four plots yield as great as 45.3 bushels, thus, 45.3 bushels could be obtained twice from the use of duplicate plots and then only with the odds greatly in favor of a lower yield.

With an increase in the number of plots allocated to each variety or strain under test, the chances of error due to random sampling are greatly reduced. The chances of the plots used in the yield determination of any one variety all falling in low or high producing areas are much lessened. It seems safe to conclude that with variable soil conditions, such as shown here, *systematic distribution of a number of plots of each variety is necessary to insure a reasonable degree of precision.*

The yield from any number of systematically distributed plots, in this instance, is liable to a systematic error due to the increase in the productivity of the first 40 plots, as they progress northward along the range. That this error cannot be entirely overcome by an increase in the number of plots is admitted. However, where there is sufficient proof of such a condition an adjustment of the plot distribution may be necessary.

The results shown in Figure 2 apply in another way. Suppose that the area is given over to fertilizer experiments or crop rotations in which wheat is used as the cash crop; each crop of ten plots covers ground sufficient for 5-1/50 or 1/40 acre plots. If a 5-year rotation A is laid out in the area represented by group 1, and another B. in

TABLE NO. 3

The Influence of an Increase in the Size of Plot on the Coefficient of Variability.

Size of Plot	No. of Plots	C. V. Coefficient of variability obtained	Expected Reduction to	Percentage reduction in C.V. due to use of larger plot	Percentage reduction in C.V. expected from use of larger plot
1/100	94	6.655			
1/50	47	6.18	4.72	7.14	29.08
1/25	23	6.15	3.08	7.59	53.72
1/10	9	5.025	1.59	24.49	76.11

TABLE NO. 4

Crops	Variety	No. of Plots used	P.E. of 1 in %	Size of Plot
Wheat	Mindum	94	4.5	1/100
Wheat	Marquis	32	6.25	1/100
Barley	O.A.C. 21	16	4.2	1/100
Oats	Victory	30	7.17	1/100
Flax	Premost	12	7.39	1/100
Pease	Arthur	7	10.44	1/100
Wheat	Marquis	29	14.22	The central 16 foot row of a 3 row plot.
Oats	Victory	28	13.16	
Barley	O.A.C. 21	34	16.48	

roup 4, a difference of 6.45 bushels per acre greater might easily occur in favor of Rotaon B. All of which could easily be due to e variability of the soil.

HE SIZE OF THE PLOT AS A MEANS OF REDUCING VARIABILITY

The 94-1/100 acre plots of Mindum were ranged to make up 1/50, 1/25 and 1/10 re plots by grouping 2, 4 and 10 adjacent ots. The yield in pounds was summed up d the value of the larger area computed in ishels. The results are shown in Table 3.

With an increase in the size of plot, the duction in the coefficient of variability does t follow that expected theoretically. The /50 acre plots only show a reduction ¼ as eat as expected. As three 1/50 acre plots ould require only slightly less land than e 1/100 acre plots, an increase in the size the plot used could not be justified. In ew of the tendency to patchiness of the soil on Field 10, it would be more desirable to use the smaller plot and increase the number of replications to four (five plots).

For the purpose of comparison the Probable Errors of single plots expressed in per cent of the mean yield for the season of 1924, Field 10 are given in table 4.

The high P.E. of the breeding nursery row tests is in part due to the irregular stands obtained. The extremely dry conditions which prevailed following seeding operations resulted in erratic germination.

These results have led to the conclusion that the 1/100 acre plot is the best adapted to the conditions at Winnipeg if replicated three or four times (4 or 5 plots). The use of the larger sized plots would necessitate fewer replications and it is felt that the increased number of smaller plots sown to each variety would give a higher degree of precision.

Part 2—The Effect of Fallow Borders on the Variability of Plot Yields

The greater vigor of the plants growing on the outer edges of plots surrounded by fallow borders has been frequently commented upon. Does this fallow border surrounding test plots of wheat increase or decrease the yield? If so, how much? Does it increase the variability, and what proportion of the plot is affected? Is the greater accuracy obtained by the removal of the rows bordering on the fallow alley-ways sufficient to warrant the expense incurred?

Barber (1) concluded that shape as well as size of plot must be considered in variety tests and that square plots gave more accurate results in variety testing than rectangular plots of the same size because of a reduction in the percentage of the total area affected by border conditions.

Mercer and Hall (2) found there was practically no difference in the variability of yields obtained from oblong and square plots of the same size, where such plots were removed from large fields, and, therefore, not surrounded by fallow borders.

Love and Craig (3) found that wheat and oats grown in 1/200 acre plots averaged 36.5 per cent more in yield, when compared with rod rows from which the end borders were removed before harvesting.

Arny and Hayes (4) show the actuel yield of outside border rows is, for oats 83.5 per cent, wheat 100.4 per cent, and for barley 123.3 per cent greater than the 13 central rows for the same varieties. For the three crops represented, the outside border rows yielded 102.1 per cent higher than the average for the central 13 rows of the same varieties. The inside border rows averaged more by 23.23% for oats, 50.36% for wheat and 42.29% for barley. For the three crops the average increase of the inside border rows compared with the central rows was 41%. They concluded that the effect of fallow alley-ways extended within the plot a distance of at least one foot.

It is reasonable to expect that border rows of plots surrounded by fallow alley-ways will, in some seasons, outyield the central rows. This would seem to be especially true in d seasons where moisture becomes a limitin factor, or under conditions where the elabo ation of certain essential plant foods is i sufficient to maintain normal productivi with continuous cropping. In moist seaso or under rust epidemic conditions, it is po sible that yields from the border rows ma actually be lowered. Border rows do n ripen with the central portions of the plo and are, for the most part, harvested befo the plants are fully matured. In moist se sons the difference in time of maturity b tween central and border rows is often ve marked.

The later maturity of the plants in the bo der rows favors the development of the ru organism, and may, in some instances, resu in a greater proportion of injury to the outer parts of the plot. Rust resistant va ieties in rust epidemic seasons, where bord conditions are not taken into account, ma have a decided advantage over non-resista types. While we have not conducted exte sive experiments to prove the contention, ce tain preliminary work indicates that su conditions may possibly exist. Some var ties may be more affected by crowding tha others and thus use border conditions to a vantage. Arny and Hayes found "indicatio that barley varieties grown in plots surroun ed by alleys were not equally efficient utilizing the additional adjacent space".

The extent to which the yield is affect by fallow borders will be in proportion the area of the plot affected. The portion the plot designated as border will depend the size and shape. Long, narrow plots ha a greater proportion of "border" than squa plots of the same size. It is obvious that t amount of border is relatively the same f small and large plots, but the actual propo tion in percentage in each case will be vast different.

Table A. has been prepared to show t percentage of plots of different sizes a shapes included in 6 inch and 12 inch bor ers:

TABLE A

Size and Shape of Plot in relation to the extent of Border Effect.

Plot Size of	Dimensions	6 inch border in sq. feet	12 inch border in sq. feet	Total Area of Plot sq. ft.	Percentage of plot in border 6 inch	12 inch
1/40	68 x 16′	83	162	1088	7.63	14.89
1/50	72.6′ x 12	83.6	165.2	871.2	9.60	18.96
1/100	72.6′ x 6	77.6	155.2	435.6	17.81	35.63

THE EFFECT ON THE YIELD OF MINDUM DURUM WHEAT FROM PLOTS SURROUNDED BY FALLOW BORDERS.

Material and Method of Experimentation

Seeding, etc. In the spring of 1924, 50 of the regular variety test plots in Field 10 were sown to Mindum durum wheat. The plots were 8 feet wide x 72.6 feet long, with 20 foot roadways between each two ranges of plots, and 24 inch fallow borders between plots. The 24 inch fallow borders represent areas not included within the margins of adjacent plots. Each plot consisted of 16 6-inch drill rows and covered an area of about 1/75 of an acre.

In order to overcome irregularities in seeding as much as possible the plots were sown to a length of about 80 feet and trimmed to 72.6 feet about 6 weeks from date of emergence. The trimming was done by stretching wires exactly 72.6 feet apart across the ends of the plots. The distance between the wires was checked at frequent intervals along the series. The growth outside the wires was removed with a hoe.

Harvesting. At harvest time the drill rows next the fallow border on either side of each plot were removed by hand and labelled outside border rows.' The second drill rows on either side of each plot were next removed by hand and labelled 'inside border rows'. The twelve remaining central drill rows were harvested with the binder in the usual way.

TABLE B.

Designation	No. of 6 inch Drill rows	Dimensions of areas	Part of an acre
Outside borders	2	12″ x 72.6 ft.	1/600
Inside borders	2	12″ x 72.6 ft.	1/600
Central Rows	12	6 ft. x 72.6 ft.	1/100
Entire Plot	16	8 ft. x 72.6 ft.	1/75

The sizes of plots from which yields were determined are summarized in Table"B".

As the distance within the plot affected by fallow borders surrounding the plots is the same for large and small plots, the yield of the 1/100 acre including the border rows was determined by taking 4/6ths of the yield of the central 12 rows, plus the yield of the two outside and two inside border rows of each plot.

The crop from the portions of the plots which were harvested by hand were threshed with the nursery thresher and yields of each computed. The central rows were harvested in the ordinary way. To obtain the yield of the 16 row plots (1/75 acre) the pounds of grain threshed from the two outside border rows, the two inside border rows, and the twelve central rows were summed.

The distance within the Plots at which the Plants are subject to fallow borders and the effect on the yield from 50 plots of Mindum surrounded by such borders is given in Table "C".

TABLE C

Source	No. of rows or plots	Yield in Bushels per acre	Yield in % of 12 central rows	Difference in yield divided by its Probable Error	Odds that the difference is significant
12 Central rows	50	40.46	100	—	—
Inside Border Rows .	100	39.75	98.26	1.21	1.39 : 1
Outside Border Rows.	100	51.19	126.52	16.53	Very great
12 Central Rows plus Borders	50	41.72	103.12	3.16	27 : 1
12 Row Plot 4/6 plus Border rows	50	42.13	104.12	4.18	190 : 1

The above data show that the outside border rows gave an increase of 26.52% in yield over the 12 central rows, but the effect of the fallow borders did not extend to the inside border rows. This correspondonds with observations made in the field. The inside border rows were of normal height and appeared to ripen uniformly with the central portions of the plots. The outside border rows were of greater height and ripened very irregularly.

It would appear that under conditions as they exist at Winnipeg the removal of two border rows on either side and to a depth of 12 inches on the ends will be sufficient to overcome the effect of fallow borders surrounding variety test plots.

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Selection in Self-Fertilized Lines as a Means of Improving Timothy.[1]

H. K. HAYES and S. E. CLARKE

University of Minnesota

Introduction.

A definite plan of procedure has been developed for breeding self-fertilized crops. The plan has been formulated as a result of a knowledge of genetic principles. With cross-fertilized crops, however, the problem of producing improved varieties is a more difficult one as under ordinary crop conditions the selection of the more desirable plants must be made on the basis of the appearance of the mother plant. The control of both the male and female parentage has been attempted in recent years by the principle known as "selection within self-fertilized lines." The method consists of artificially inducing self-pollination of desirable appearing plants, the selection in the following generations of the more desirable appearing plants and their subsequent self-pollination. This leads, eventually, to the production of partial or complete homozygosis. Desirable lines can be used either as material for the synthesis of a new variety, or, if sufficiently desirable, a particular self-fertilized line may itself furnish the foundation for a new variety.

The method can be used only for those plants which are self-fertile or partially so although recent studies indicate that self-fertile lines can be obtained in several crops which were formerly thought to be self-sterile. The success of the method depends upon the effects of self-fertilization. The method is used rather widely at the present time in maize breeding and is also being tried with other cross-pollinated crops. The extent to which self-fertility is present in cross-pollinated plants as well as the degree to which there is a reduction in vigor as a result of selfing is of great interest. The present paper presents the results obtained from selection in self-fertilized lines in timothy.

Previous studies in timothy breeding will be mentioned briefly and only those in relation to the principle of selection in self-fertilized lines. The extensive experiments in timothy improvement carried out at Cornell have proved that timothy varieties consist of numerous types and that by selection better strains can be obtained. A single year's test by the use of self-fertilized seed was made by Webber (6) to determine the extent to which particular strains bred true. The better types were determined from the combined test of clonally propagated lines and lines obtained from self-fertilized seed. Following the single year of self-fertilization open pollination within a strain was allowed and it appears that Webber thought that the loss in vigor accompanying self-fertilization might be regained by open pollination within the strain. The method of breeding timothy at Svalöf, as reported by Witte (7) does not differ essentially from that practiced at Cornell. Two improved lines, Svalöf's Gloria and Svalöf's Primus, that were distributed from the Svalöf station, both outyielded ordinary timothy.

Frandsen (2) compared the percentage of seed set under (1) self-fertilization, (2) cross-fertilization, and (3) free flowering and concluded that timothy was highly self-sterile. Hayes and Barker (3) found that some clonal lines of timothy set much more seed under conditions of self-fertilization than others. The progeny of some self-fertilized lines were hghly resistant to stem rust (1), and in some lines white seedlings appeared. They concluded that selection in self-fertilized lines was a logical means of freeing a strain of undesirable recessive abnormalities and of obtaining disease resistant strains.

A recent paper by McRostie (5) states that self-fertilization in timothy does not seem to be accompanied by any decrease in vigor of the inbred progeny. Twenty-six strains which have been inbred for five generations were studied at Ottawa. Most of these strains consistently outyielded all commmercial mixtures.

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The principle of selection in self-fertilized lines is applicable to cross-fertilized plants from which seed can be obtained under conditions of controlled self-pollination, and for this reason it is important that the combined experience of different investigators be made available. The isolation of self-fertile lines from crops in which self-sterility is frequently encountered also is of much interest.

Material and Methods

The lines used for the present study are for the most part the progeny of plants which at University Farm, St. Paul, Minnesota, survived the winter of 1917-18 when the majority of the plants in the timothy nursery were winter killed. The original material consisted of eleven selections furnished by the Cornell Department of Plant Breeding and of six Minnesota selections.

The present method of work consists of starting the lines in the greenhouse about the last of February, each plant being grown in a separate pot. The plants are transplanted in the field during the latter part of April. By this method good seed production is obtained the first year and a single self-fertilized generation can be obtained each year. Self-fertilization is insured by covering the heads of selected plants with a paper bag. The bag is then tied to a stake which prevents the breaking of the culms.

The comparative vigor of selfed lines and of commercial varieties was determined by the average yield of individual plants when grown in rows three feet apart and spaced a distance of eighteen inches apart in the row. The determination of yielding ability was made in some cases from single rows of from ten to thirty plants and in other cases from strains grown in replicated rows. The data on yield per plant were obtained on a dry matter basis.

The present purpose is to furnish data regarding the inheritance of self-sterility as determined from the number of seeds set per head and the effect of self-fertilization upon plant development.

Experimental Results

Desirable appearing plants were selected in various first-year selfed lines in 1923 and several heads of each were covered before blooming with a paper bag.* The average number of seeds set per head was determined. The average seed setting per head in 1923 from forty-one selected plants was compared with the average number of seeds obtained per head in the 1924 progeny which was grown from 1923 self-fertilized seed. In 1924 the average seed setting per head was obtained as a rule from several selected plants within each self-fertilized line.

The results are presented in Table 1. While the lines differed to some extent in size of head the number of seeds obtained is largely an expression of the relative ability of different lines to set seed under conditions of controlled pollination.

* J. B. Harrington gave efficient aid in 1923 in carrying out the experiment.

Table I.—Self-fertilization of Timothy. Correlation of Seed Setting for 1923 and 1924.

Classes for Number of Seeds set per Head, 1924.	Classes for Number of Seeds Set per Head, 1923.																						
	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	Total
1	4	2		1																	7
4	1	5																			6
7		2	1	4																	7
10					1	1	1														3
13	1						2														3
16																					0
19						1		1	1	1										1	5
22					1			1													2
25				1						1											2
28							1							1							2
31															2						2
34														1		1					2
	6	9	1	6	2	2	4	2	1	2	0	0	0	2	2	1	0	0	0	1	41

$r = .829 \pm 0.033$

Table 2.—Average Yields per Plant of the First Cutting for the Years 1923 and 1924 in the Progenies of Lines Started in 1922.

Source	Dry weight per plant in grams 1923	1924
F_1 crosses of clonal lines from rust-resistant plants	49	113
Open-pollinated seed increased in isolated plots from several clonally propogated rust-resistant plants	35	109
One-year selfed lines from clonal lines selfed in greenhouse and field	27	108
Northrup King Sterling (Commercial)	19	97

A correlation coefficient of $.829 \pm 0.033$ was obtained which is highly significant. These results corroborate those of Hayes and Barker (3) who observed a marked correlation between the percentage of seed set under various conditions. It would appear that variability in the self-fertility of different lines of timothy is due to genetic causes.

While some lines produced only a small number of seeds per head each of the two years the majority set sufficient seed so that the method could be used to advantage in breeding studies.

The plants grown from commercial seed were very variable. Although the self-fertilized lines differed among themselves in such characters as erectness, vigor, compactness, etc., several lines appeared very uniform in habit of growth after having been self-fertilized for two years and they were also highly vigorous.

A comparison is given in Table 2 of the average yields per plant of one year self-fertilized lines and Northrup King Sterling commercial for the first cutting obtained in 1923 and also in 1924.

The selected lines outyielded the commercial variety both years. The yield trials were not arranged primarily for this purpose and accordingly a somewhat different procedure was followed in 1924 for the next generation of selfed lines. The yield trials in 1924 consisted of a 10-plant row of each culture or check and a check row of commercial plants was planted at distances of five rows apart throughout the plot.

The difficulty of such studies was apparent in 1924 when individual rows of Northrup King Sterling commercial varied in yield from an average of 32 grams per plant to 72 grams. By comparing some lines which were self-fertilized for a two-year period with nearby rows of commercial plants it was apparent, however, that some two-year selfed lines were uniform and apparently more desirable than the commercial variety.

The data in Table 3 are presented for the purpose of bringing out certain facts regarding comparative vigor of plants of commercial timothy and of certain cultures obtained from self-fertilized seed.

Table 3.—Comparison of Certain Desirable Selfed Lines with Nearby Commercial Cultures

Variety	Years selfed	Row No.	Ave. Yield per plant
Northrup King Sterling	0	11	72
Culture 54	2	12	70
Culture 55	2	13	76
Culture 66	1	24	69
Culture 67	1	25	66
Northrup King Sterling	0	26	47
Culture 71	1	29	66
Northrup King Sterling	0	31	49

Fig. 1. Timothy grown from commercial seed. The plant on the right is very open in habit of growth, while the other two are of a somewhat more compact type.

The two-year selfed Culture No. 55 yielded an average of 4 grams per plant more than the nearby commercial row which was also the highest yielding commercial row in the field. The photographs in Fig. 1 and Fig. 2 illustrate the comparative vigor and habit of growth of the commercial and of the two-year selfed line Culture No. 55. This culture was uniform in habit of growth, was rather leafy and of a compact growth habit, and appeared desirable for other characters. Rows from 24 to 31 inclusive furnished data which indicate the superiority of certain one-year selfed lines.

By selfing several plants in certain cultures, through the plan of covering several heads before blooming with a paper bag, sufficient seed was obtained so that a test in replicated rows can be made by sowing the seed in bulk in the row. This plan is of promise as an aid, in comparative tests of the value of selfed lines, in the control of soil heterogeneity.

Discussion of Results

From the results obtained it appears reasonable to conclude that selection within self-fertilized lines is a desirable method of breeding such cross-fertilized crops as timothy. It has been pointed out by Kirk (4) that red clover seems to be markedly affected by self-fertilization as extreme reduction in vigor in red clover as a result of self-fertilization appears rather frequent. Maize, as a rule, is greatly reduced in vigor as a result of self-fertilization although not to as great an extent as red clover, while timothy, on the other hand, can be self-fertilized without greatly affecting vigor.

Why reduction in vigor as a result of self-fertilization occurs in some crops, such as red clover and corn, and why in other crops, such as timothy, reduction in vigor as a result of selfing is not so marked is an unanswered question. The differences in the effect of selfing in these crops must in some way be correlated with the genetic condition. Perhaps, in red clover the important characters are dependent upon factors located in nearly all chromosomes. It is also possible that several factors in each chromosome may condition important characters. Most characters are probably heterozygous and those dependent upon many factors may be more markedly influenced by self-fertilization than if the character was dependent on a smaller number of factors. The correct explanation must await further and more intensive research.

Fig. 2. Timothy Culture 55, two years selfed. This is one of the best of the selfed lines and it outyielded the commercial strain.

Summary of Results

1. In timothy the average seed-setting per head of 41 plants, which represented different apparent abilities to set seed under conditions of self-pollination, was determined in 1923. The average seed-setting under conditions of controlled self-pollination, as determined from several plants for each progeny of the 41 selected parent plants, was determined in 1924. A correlation coefficient of $.829 \pm 0.033$ was obtained for seed setting under these two conditions for the 41 lines. This very significant correlation indicates that seed setting under conditions of self-pollination is probably due to genetic causes. The actual number of seeds set under these conditions varies from almost 0 to 66 seeds per spike as an average for an individual plant.

2. Self-fertilization in timothy does not lead to as great reduction in vigor as has been observed in maize. Some selfed lines yielded less and others considerably more than the average for the commercial variety.

3. Selection in self-fertilized lines is a logical means of freeing the lines of undesirable recessive characters and of obtaining vigorous lines which excel in such important characters as yielding ability and disease resistance.

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The Relation of the Salt Concentration of the Culture Solution to Transpiration and Root Respiration.

J. D. NEWTON

Soils Department, University of Alberta, Edmonton.

In previous experiments (1) it was shown that there is a reasonably close correlation between the rates of transpiration and of root respiration, when plants are absorbing from a given culture solution. This indicated that the rate of root respiration is a measure of the energy which the plant root expends in absorbing from the solution in which the plant is growing, and it was then suggested that it might require more energy to absorb from concentrated solutions than from dilute solutions. This appears to be borne out by the experiments now reported.

It is found that when the salt concentration of the culture solution is increased, the resulting decreases in rates of transpiration are not accompanied by corresponding decreases in rates of root respiration. In this connection attention is called to the concluding line in Table 1, and to the two lines in Table 2, which show the quantities of CO_2 evolved from the roots per cubic centimeter of water transpired, when plants are grown in culture solutions of different salt concentration. It will be observed that as the salt concentration increases, the quantity of CO_2 evolved per cubic centimeter of water transpired increases also. It therefore seems necessary to conclude that plants expend more energy at their roots in absorbing a given volume of solution from a more concentrated than from a less concentrated solution.

The method of conducting these experiments was described in the paper (1) previously referred to. Barley plants were used in both series, Tables 1 and 2, and the measurements were made shortly before the plants had reached the heading stage. Series A plants were about 40 days old when tested, and Series B plants were about 50 days old at the time of the first test, and 57 days old at the time of the second test. The plants for the experiments reported were grown in Hoagland's culture solution, the composition of which was given in an earlier paper (2). Immediately before the measurements reported in Table 1 were made, the concentration was altered to those given in the Table, and the salt proportions of the culture solution were changed to those of "Shive's Best" solution (3). The most concentrated solution was first prepared, and the other solutions were prepared by diluting this so as to obtain concentrations of desired osmotic pressure value. With reference to Table 2 it should be said that for ten days previous to the first test the plants were grown in Shive's solution with a concentration, expressed in terms of osmotic pressure, of 1.5 atmospheres. The concentration was altered to those given in Table 2 immediately before the first test, and these new concentrations were maintained until after the second test was completed.

Most of the solar energy arrested by plant leaves is used to vaporize the water of transpiration after this water reaches the leaves; less than one per cent. of the solar energy arrested is used for photosynthesis (4). But in addition to the relatively large amount of energy used to vaporize the water of transpiration, some energy must be required to bring the solution into the roots and up to the leaves.

The absorption of salts from the soil or culture solution is believed to be governed by the ordinary laws of diffusion from regions of high concentrations to regions of low concentration. But it is a very complicated process, limited by factors such as modified permeability and Donnan equilibrium, and the mechanism is only partly understood. It seems clear, however, that plant roots cannot exert a selective action without an expenditure of energy, and the experiments reported in this paper indicate that the expenditure of energy at the plant roots, as related to transpiration, is increased when the concentration of the culture solution is increased.

Table 1—Concentration of Culture Solution in Relation to Transpiration and CO_2 Evolved from Roots.

Experimental Series A.

	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6
Concentration of culture solution	0.1 atmosphere			5.0 atmosphere		
Water transpired in 48 hours, May 2 - May 4, 1924.	173. c.c.	172. c.c.	162. c.c.	111. c.c.	119. c.c.	95. c.c.
CO_2 evolved from roots in 48 hrs. May 2 - 4, 1924.	36.5 mgm.	31.1 mgm.	25.6 mgm.	38.2 mgm.	46.0 mgm.	37.0 mgm.
CO_2 evolved from roots per c.c. water transpired..	.21 "	.18 "	.16 "	.34 "	.38 "	.39 "

Table 2—Concentration of Culture Solution in Relation to Transpiration and CO_2 Evolved from Roots.

Experimental Series B.

FIRST TEST

	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8
Concentration of culture solution	0.1 atmosphere		1.5 atmospheres		4.0 atmospheres		6.0 atmospheres	
Water transpired in 48 hrs. Dec. 6 - 8, 1924	75. c.c.	85. c.c.	78. c.c.	45. c.c.	35. c.c.	33. c.c.	26. c.c.	28. c.c.
CO_2 evolved from roots in 48 hrs. Dec. 6 - 8, 1924..	28.8 mgm.	23.1 mgm.	32.8 mgm.	30.4 mgm.	33.7 mgm.	24.9 mgm.	19.7 mgm.	23.4 mgm.
CO_2 evolved from roots per c.c. water transpired.	.30 "	.27 "	.42 "	.68 "	.96 "	.75 "	.76 "	.84 "

SECOND TEST

Concentration of culture solution	0.1 atmosphere		1.5 atmospheres		4.0 atmospheres		6.0 atmospheres	
Water transpired in 48 hrs. Dec. 13 - 15, 1924.....	88. c.c.	90. c.c.	74. c.c.	46. c.c.	29. c.c.	31. c.c.	20. c.c.	17. c.c.
CO_2 evolved from roots in 48 hrs. Dec. 13 - 15, 1924	17.7 mgm.	21.7 mgm.	27.2 mgm.	25.7 mgm.	22.3 mgm.	22.1 mgm.	12.6 mgm.	16.2 mgm.
CO_2 evolved from roots per c.c. water transpired.	.20 "	.24 "	.37 "	.56 "	.77 "	.71 "	.63 "	.95 "
Size of plants—Tops green.....	32.3 gm.	38.2 gm.	46.0 gm.	27.6 gm.	33.3 gm.	26.5 gm.	25.5 gm.	20.3 gm.
—Tops dry	2.9 "	3.3 "	4.2 "	2.5 "	3.3 "	2.7 "	2.5 "	2.1 "

It is clearly shown in these experiments that the rate of transpiration is decreased when the concentration of the culture solution is increased. The effect is pronounced, and this is a factor which should be considered in experiments dealing with water requirements of plants, together with the other factors influencing water requirements. From a practical standpoint it is important to study all factors influencing water requirements of plants, because soil moisture is commonly the limiting factor in crop production on prairie farms. The soil solution of fertile soils is normally more concentrated than the soil solution of infertile soils (5). Consequently the rate of transpiration is reduced, and the water requirement of plants in relation to yield is smaller, on fertile soils. For example, in experiments to determine the water requirements of various crops on irrigated land at Brooks, Alberta, Snelson found that high yields could be obtained on fertile soils with less water than on infertile soil (6).

SUMMARY

The experiments reported show that the rate of plant root respiration, as related to transpiration, is increased when the salt concentration of the culture solution is increased. This indicates that as the concentration of the culture solution is increased, the plant roots must expend more energy in absorbing a given volume of solution.

It is further shown that the rate of transpiration is decreased when the concentration of the culture solution is increased, and it is pointed out that the concentration of the soil solution is one of the factors governing water requirements of crops. This is a matter of practical importance, as the concentration of the soil solution may be modified to some extent by cultural and manurial treatments.

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Dominion Department of Agriculture Notes

EXPERIMENTAL FARMS BRANCH

Division of Chemistry

During 1925 this Division has issued the following bulletins:

(1) Bulletin No. 44—"Influence of Grain Growing on the Nitrogen and Organic Matter Content of the Western Prairie Soils of Canada", by Dr. F. T. Shutt.

The material in this bulletin was first presented in the form of a paper to the Agricultural Section of the British Association for the Advancement of Science, in Toronto, Auguse, 1924, and is supplementary to bulletin No. 6, second series, "Western Prairie Soils: their Nature and Composition", published in 1910. In the new bulletin, No. 44, the author gives a detailed account of experiments carried on during the past ten years to determine the effect of continuous grain growing (with summer fallowing) and cropping under a scheme of rotations including the growth of grasses and clovers, on the soils of Manitoba, Saskatchewan and Alberta. The results of the experiments show (1) that for richness in plant food, especially nitrogen, and for a favorable physical condition, due chiefly to the large proportion of semi-decomposed organic matter they contain, these prairie soils are in a class by themselves ; (2) that grain growing with its necessary summer fallowings is destructive of the soil's nitrogen to a very serious degree; (3) that the maintenance of soil fertility can be accomplished through the adoption of a system of farm management which will include the return of part of the plant food, and the systematic putting of the land into sod (grasses and clovers).

(2) Bulletin No. 49. New Series. "Animal Products" by Dr. F. T. Shutt and S. N. Hamilton. The bulletin contains the chemical analysis of over fifty samples of feeding stuffs, for the most part the by-products of the packing house, slaughter house and fish canneries. The data from the analyses have led to the drafting of definitions of the various classes of animal products, the proper classification of the samples submitted and in some cases, the setting and revising of standards for protein, fat and phosphoric acid content.

(3) Bulletin No. 50. New Series. "Silage" by Dr. F. T. Shutt and S. N. Hamilton. This bulletin contains the analysis and crop data of a number of forage crops being at the present time used for ensilage. The bulletin presents data of value in the selection and treatment of crops for ensiling.

Two papers of educational value and scientific interest are also being prepared:

(1) "Nitrogen Compounds of Rain and Snow" by Dr. F. T. Shutt and Miss B. Hedley, M.A., read to the Chemical Section of the Royal Society of Canada, at its meetings May 19-22, 1925. In this paper are presented the results of an investigation into the fertilizing value of the nitrogen compounds in rain and snow, as prosecuted for the past seventeen years (1907-1924) at the Chemical Laboratory, Central Experimental Farm.

(2) "Influence of Environment on the Protein Content of Wheat" by Dr. F. T. Shutt—to be presented at the joint meeting of the Society of Chemical Industry and the Canadian Institute of Chemistry to be held at Guelph, June 3rd, 1925. A study of the influence of environment (climatic conditions, nature of the soil and culture received by the crop) has been rendered possible by the accumulation of data, for sixteen years, of the chemical content of wheat, grown under such varying environmental conditions as are offered at the Dominion Experimental Stations, situated at various points from coast to coast.

Cereal Division

Mr. Cyril Goulden who is at present completing his work for his Ph.D. Degree at St. Paul, Minnesota, will join the staff of the Cereal Division, Experimental Farms' Branch, Federal Department of Agriculture, some time during the month of May. Mr. Goulden will be located at the College at Winnipeg where he will take charge of the work in genetics

involved in connection with the special rust investigation which is being launched this year. Mr. Goulden is a Canadian by birth, and is a graduate of the University of Saskatchewan at Saskatoon. He took his Master's Degree also at that place, under Dr. Thompson, specializing in certain cytological phases of plant breeding work. He is reported to have done exceptionally well at St. Paul and will come to his new work particularly well qualified.

In addition to carrying on research work in connection with the rust problem, Mr. Goulden will be the western representative of the Cereal Division, in which capacity he will be expected to keep closely in touch with the work of the different Experimental Farms and Stations, both federal and provincial, as well as with all organizations, institutions and individuals who are actively interested in the question of better seed.

Poultry Division

This fall will see the first registered cockerels in Canada. It has taken five years to produce them, but they will represent the highest peak of any system of pedigree breeding ever officially undertaken by any country.

A registered cockerel is the offspring of two generations of registered dams, the process of breeding being in brief this:—A pullet enters a Laying Contest upon one of the Experimental Farms. If she is free from standard disqualifications, typical of the breed, lays 200 or more normal eggs that weigh 24 ounces to the dozen, within the contest year, (52 weeks), she becomes eligible and is registered in the Canadian National Live Stock Records. The next spring she is bred to an approved male, and a pullet from this mating enters the contest the succeeding fall as a second generation bird. If this second generation pullet qualifies and is registered she is bred the following spring to an approved male, and the male offspring from this mating may be registered providing they pass all breed, health, and individual qualifications.

Even though the number that will be registered this fall is not large, probably but a few hundred in all Canada, a representative lot of these registered cockerels, officially banded and tatooed with the breeder's registered mark, will be on exhibition during the month of October, at Wembley, in the space secured by Canada in the exhibit of the British National Poultry Association.

The regulations governing the free entry into Canada of pure-bred domestic fowls for the improvement of stock have been amended by the Department of Customs and Excise, under memorandum dated April 4, 1925.

Henceforth no free entry is to be accepted for Baby chicks or Adult Fowls (fully feathered), unless the importer submits with the entry the following information:

(a) In the case of Baby chicks, a sworn declaration from the owner and shipper, on a specified form giving the breed, chick band numbers, consignee, and a pedigree for two generations showing birds either with trap-nest records or birds with records of wins made at recognized A.P.A. shows.

(b) In the case of Adult Fowls, a certificate from the shipper, giving the breed, band numbers, consignee, and assurance that the fowl are purebred and qualify under the standards of the American Poultry Association.

DAIRY AND COLD STORAGE BRANCH

Bulletin No. 48, New Series, of the Department of Agriculture, was published during May by Dr. E. G. Hood and Mr. A. H. White of the Division of Dairy Research, Dairy and Cold Storage Branch, on "The Cause and Prevention of Mould in Canadian Pasteurized Butter." The Bulletin is designed to give practical suggestions and to be of assistance to the average creamery operator in combating mould in pasteurized butter.

At present the Division is making a study of Canadian Butter Salts with reference to their bacteriological content, chemical and physical properties. Commercial rennets are also being investigated to determine the effect of storage, bacteriological content, coagulation time, etc. in relation to cheddar cheese manufacture.

ENTOMOLOGICAL BRANCH

The following promotions have been made recently in the Entomological Branch:

Henry Gordon Crawford, from Entomologist to Chief, Division of Field Crop Insects.

William N. Keenan, from Assistant Entomologist to Entomologist.

Edward R. Buckell, from Assistant Entomologist to Entomologist.

Alan G. Dustan, from Assistant Entomologist to Entomologist.

Cecil R. Twinn, from Junior Entomologist to Assistant Entomologist.

Concerning the C.S.T.A.

DOMINION AND LOCAL ELECTIONS

The results of the Dominion election for officers for the year beginning June 1st, 1925, are as follows:

President—E. A. Howes, University of Alberta, Edmonton. (Elected by acclamation).

Vice-Presidents—G. C. Creelman, Beamsville, Ont.; L. P. Roy, Dept. of Agriculture, Quebec, P.Q.

Honorary Secretary—L. H. Newman, Experimental Farm, Ottawa, Ont.

The personnel of the entire Dominion Executive and of those local branch Executives which have so far been appointed, are given elsewhere in this issue.

APPOINTMENT OF DR. CHARRON

Dr. A. T. Charron, formerly Provincial Agricultural Chemist for Quebec and Director of the Provincial School at St. Hyacinth, P.Q., has been appointed Assistant Deputy Minister of Agriculture for Canada. Further details will be found in the French section of this issue.

Dr. Charron has been prominently identified with the C.S.T.A. since its organization and the Society extends to him its hearty congratulations at this time.

LIBRARY OF THE DOMINION DEPARTMENT OF AGRICULTURE

What was formerly the Library of the International Institute of Agriculture at Ottawa, has now become the Library of the Dominion Department of Agriculture. It is located on the 3rd floor of the West Block, Parliament Buildings. Members of the C.S.T.A. should take advantage of the reading facilities offered by this Library, which is probably the most completely equipped one of its kind in Canada.

CONVENTION PROGRAMMES

The Official Programmes of the Fifth Annual Convention will be mailed to all members of the Society on Monday, June 8th. There is, therefore, no need to give any details of the programme in this issue. Members who plan to attend the Convention should have their tickets routed via Calgary in order to take advantage of the motor trip which is being arranged from that point on Saturday, June 27th.

FEE REDUCTION

Reference has been made in a previous issue to the proposed reduction of annual fees from $6.00 to $5.00, which is to be considered at the Convention. Practically all local branches appear to be in favour of the proposal, so that there is little doubt that it will be adopted, and the Executive will have to be prepared to operate in future on a revenue reduced $750.00 per annum.

It is interesting to note that the $10.00 annual fee, adopted at the Organizing Convention in June, 1920, will probably become $5.00 in June, 1925. This is an average annual reduction of $1.00 and the fee has now reached a figure which is quite beyond criticism, particularly as the locals are all financed out of it and the magazine is distributed to members free. As a matter of fact practically all operating expenses of the Society will, in future, have to be borne by the magazine and not by the members. Whether or not that is possible remains to be seen.

MEMBERSHIP

While final figures are not yet available, it is likely that the 1924 membership of 734 will show a slight increase in 1925, when the General Secretary's report is presented. It is expected that a carefully organized membership campaign will be conducted next winter with the object of having 1,000 members enrolled at the time of the 1926 Convention, which is likely to be held either at Ottawa or Quebec.

DEATH OF S. J. HETHERINGTON

It is with profound regret that we learn of the death, at Madison, Wis., on May 3rd, of Samuel Judson Hetherington. At the time of his death, he was on leave of absence from the Saskatchewan Department of Agriculture, completing a graduate course in Marketing at the University of Wisconsin, and would have received his Master's degree in June.

S. J. Hetherington was born at Codys, N.B., on July 26, 1890, and graduated from Macdonald College in 1921. During the war he served as Lieutenant in the Royal Air Force in Canada. Since 1921 he has been in the employ of the Saskatchewan Department of Agriculture as Markets Specialist and Co-operative Organizer.

The funeral was held at Codys, N.B., on May 10th.

APPLICATIONS FOR MEMBERSHIP

Cox, Kenneth (Toronto, 1924, B.S.A.) Nappan, N.S.

Derby, H. A., Department of Agriculture, Edmonton, Alta.

Fortin, D. (Montreal, 1921, B.S.A.) Ile Verte, P.Q.

Gale, F. G. (Dartmouth, 1876, B.A.) Waterville, P.Q.

Gale, R. L. (McGill, 1914, B.A.) Waterville, P.Q.

Gauthier, J. R. (Laval, 1923, B.S.A.) Val Brillant, P.Q.

Lemire, W. (Montreal, 1921, B.S.A.) St. Martine, P.Q.

La Haye, A. (Montreal, 1922, B.S.A.) St. Zephirin, P.Q.

Lesage, C. (Montreal, 1922, B.S.A.) La Trappe, P.Q.

Leggatt, C. W. (Toronto, 1921, B.S.A.) Calgary, Alta.

MacDermid, J. R. (Toronto, 1923, B.S.A.) Newport, Vt.

Savoie, A. (Montreal, 1924, B.S.A.) Quebec, P.Q.

Smith, N. S. (Manitoba, 1915, B.S.A.) Olds, Alta.

Tremblay, G. (Montreal, 1921, B.S.A.) La Trappe, P.Q.

ANNUAL MEETING, C.S.G.A.

The annual meeting of the Canadian Seed Growers' Association will be held at the University of Alberta, Edmonton, on June 22nd and 23rd, immediately preceding the annual Convention of the C.S.T.A.

NOTES

T. H. Lund (O.A.C. '12) has resigned from the staff of the Ontario Agricultural College, where he has held the position of Associate Professor of Bacteriology since 1920. It is reported that the vacancy is to be filled by the appointment of D. B. Shutt (O.A.C. '22), who is now completing graduate work at East Lansing, Mich.

E. R. Bewell (Manitoba '14) who has been with the B.C. Dept. of Agriculture, on potato improvement work since July, 1923, has been appointed District Agriculturist at Duncan, B.C., succeeding W. M. Fleming (Alberta, 1919), who is now on the staff of the Dominion Experimental Station at Summerland, B.C.

The General Secretary is arranging to meet C.S.T.A. members at Fort William on June 16th, Winnipeg June 17th, Regina June 18th and Saskatoon June 19th, on his way to the Edmonton Convention. The meetings will be entirely for the purpose of discussing Society affairs in general, and particularly those matters which are likely to be given consideration at the Convention.

No printed copy of the Constitution and By-laws of the Society has been distributed to the members since March, 1923, when it was embodied in the C.S.T.A. Booklet. Amendments were made in June 1923, again in 1924, and further changes will be made this month. It is therefore proposed that copies of the Constitution and By-laws, as amended at the 1925 Convention, be mailed to all members as soon after the Convention as possible.

NIAGARA OUTING

About twenty members of the Western Ontario local, with their wives and friends had lunch at the Village Inn, Grimsby, on May 23rd, and visited the Horticultural Experiment Station at Vineland in the afternoon.

he weather was exceptionally cold and unleasant, and this undoubtedly accounted for ie small attendance. Some of those present luncheon were: Mr. and Mrs. J. A. Carroll, Ir. and Mrs. J. Coke, G. C. Creelman, J. M. reelman, G. H. Dickson, Mr. and Mrs. F. . Grindley, C. D. Jarvis, Mr. and Mrs. A. eitch, Mr. and Mrs. C. C. Lyster, Mr. and Irs. H. W. Neff, J. A. Neilson, E. F. Palmer, Vm. Strong, President and Mrs. J. B. Reylds, and W. H. Wright.

The annual meeting of the local was held Vineland in the afternoon.

HE NEW BUCKEYE INCUBATOR BOOK

Anyone interested in the baby-chick busiess, or in almost any phase of the poultry ndustry, should write for a copy of "The olden Opportunity", now being distributed y the Buckeye Incubator Company of Springeld, Ohio. It is above the level of most atalogs, is exceedingly well illustrated in olors, and contains a fund of useful informaon. Its publication is, we hope, an indicaon of business development following the nprecedented depression of the past few ears.

The Buckeye Incubator Co. manufactures rooders and incubators exclusively, and this ook deals almost entirely with the specificaons and merits of their machines.

THE GENERAL OUTLOOK

After five years of development the C.S.A. may be considered to be approaching aturity. Those who have been closely asciated with the Society are fully aware that e progress made since 1920 has not always en steady and has never been made witht obstacles of some kind to be overcome. pposition and criticism were of course excted at the outset and it was fully realized at there would be those who would quesn the usefulness of the organization and e need for its existence. It was hardly excted, however, that the Society would, in e years, be quite as far-flung and as cometely organized as it is today. The organtion of locals was completed within six nths of the Organizing Convention, and e establishment of an official organ, under ciety ownership, followed one year later. e locals and the magazine have formed the al organs of the Society and have furnished that connecting link without which it is doubtful whether continued activity would have been possible.

It must be borne in mind, by those who feel that membership fees have been too high, that the Society has received no financial assistance of any kind and has had to be self-supporting from the beginning. The fact that fees have been reduced is due entirely to the fact that the magazine has produced a surplus and that this has been applied to overhead expenses which, in the early days, were paid by the members.

One of the most encouraging features of the Society's development has been the recognition given to the organization, and the official organ, in practically every country in the world. The methods of organization adopted by the Society, and the history of its development, have been furnished gladly to other countries, where a need was felt for a similar body. Useful affiliations have been formed—notably those with the Royal Society of Canada and the American Association for the Advancement of Science. Articles in *Scientific Agriculture* have been abstracted and published in many journals in Great Britain and foreign countries. This form of publicity has given the professional agriculturists of Canada a status that might not have been possible except through organized effort, but it is a benefit of organization which is little appreciated. The publication of the C.S.T.A. "Who's Who" in 1924 added the final touch, and its distribution gave to other countries a needed directory of technical workers in agriculture in Canada.

The wholesale handling of text books is a distinct membership privilege of which increasing numbers are taking advantage.

The membership list has shown a steady increase from 411 in 1920 to approximately 750 in 1925, and there is reason to hope that this will continue.

There is no question that the existence of the C.S.T.A. has provided protection and strength to the profession, and if its activities were confined solely to the local branch meetings, annual conventions, magazine and general propaganda, its organization would be entirely justified.

We must, however, expect criticism and skepticism to continue, but we must not allow either to disturb our confidence or slacken our progress.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

La Repartition des Capitaux sur la Ferme.

par ANDRE AUGER

Ministère de l'Agriculture, Québec

Facteurs qui doivent l'influencer

En agriculture comme dans l'industrie ou le commerce, il faut du capital pour réaliser des profits. Pour l'industriel et le commerçant il s'agit bien souvent d'avoir un gros chiffre d'affaires pour retirer des revenus; ne voit-on pas des marchands compter uniquement sur un nombre considérable de petites ventes rapportant parfois des profits insignifiants à l'unité, mais importants dans l'ensemble. Et pour se faire une clientièle, le marchand ne néglige aucun détail: édifices spacieux, aménagés avec tout le luxe et le comfort imaginables, annonces de tout genre, au moindres caprices des clients, etc., etc. déboursés parfois considérables pour plaire

Le cultivateur qui veut, lui aussi, réaliser des profits peut-il se placer sur un pied d'égalité avec le marchand? Non, et pour les raisons que voici:

1°) Sur la ferme, la plus grande partie du capital ne se renouvelle pas, et, même pour celui qui se renouvelle, il ne le fait que très lentement;

2°) Dans le commerce le profit est immédiat, en agriculture il est subordonné à la production et souvent lent à venir;

3°) La plupart des denrées agricoles sont des produits périssables, ce qui veut dire que, outre la demande sur laquelle on peut compter, il y a toujours un risque de perte par défaut de conservation.

Ceci nous amène à étudier les facteurs qui doivent nous guider dans la répartition des capitaux sur la ferme. Ils peuvent se résumer à trois chefs principaux: La grandeur de la ferme, le système de culture et le marché.

Grandeur de la ferme

Une ferme bien équilibrée doit voir s capital réparti dans chaque départem d'après l'importance de ce dernier. Il e sur la ferme, des capitaux qui ne produis presque rien, quand ils ne sont pas plutot u cause de dépense. Ainsi en est-il de maison du cultivateur; évidemment elle nécessaire, elle fournit le logement à s propriétaire, mais il ne faut pas oublier q dans bien des cas on constate que la mais grève fortement le budget du fermier. E il bien logique par exemple d'avoir une m son de $5450.00 quand la terre elle même vaut que $6400.00? ou d'avoir une gran de $4600.00 et des machines pour $1740 sur une terre de $2050.00? Non, évidemme

Les bâtisses demandent une mise consid able de capital, accusent tous les ans u dépréciation importante et nécessitent souv des réparations alors que par contre elles rapportent rien directement. Loin de n l'idée de critiquer les constructions modern elles ne sont pas plus dispendieuses à c struire que celles qui se font encore d'ap les anciens modèles et, ensuite, les constr tions sont d'absolue nécessité en notre pa Mais notre but est d'attirer l'attention sur part de capital qui doit aller aux bâtisses cela comparativenent avec la valeur de terre et des profits qu'on en peut attendre.

La répartition du capital dans chaque partement de la ferme est influencée p la grandeur de celle-ci, en ce sens que p l'étendue de la ferme sera considérable, p chaque département devra avoir de l'impo ance, a moins qu'on se livre à une producti

éciale. Et il ne s'agit pas simplement ici
ı bétail ou des cultures, mais aussi des con-
ructions qui doivent être aménagées de
anière à abriter le bétail et les récoltes, avec
confort nécessaire, mais sans luxe.

Système de culture

Le système de culture a une importance
nsidérable sur la répartition des capitaux.
elle ferme se livre à telle culture spéciale,
ır conséquent, il lui faut investir un capital
us considérable que pour telle autre produc-
on qui n'est que secondaire. Mais est-ce
dire pour cela qu'il faille négliger certains
partements pour faire de la spécialité? Les
rmes qui réussissent le mieux sont celles qui,
itre une production spéciale dans laquelle
ı n'a engagé qu'un léger surplus de capital,
occupent également de production générale.
e système de culture évidemment doit être
oproprié aux conditions de sol et de climat
surtout au marché.

Marché

Un débouché avantageux pour telle pro-
ıction doit nous inviter à faire une mise
e capital plus considérable afin d'améliorer
tte production tant au point de vue quantité
ıe qualité. Le marché est un des facteurs
s plus importants devant affecter le système
e culture et la part de capital réservée à
aque production. De nos jours on pourrait
ut-être dire que le capital le plus important
ı vue du marché est le capital "travail" qui
occupera de l'amélioration des produits
our l'obtention des plus hauts prix.

Comment se fait le répartition des capitaux en pratique

Un inventaire couvrant les années 1923-24,
our 15 fermes différentes, prises chacune
ns un comté différent, et représentant assez-
en le moyenne de la province de Québec,
t inventaire suivi d'une étude sérieuse de
dministration totale et détaillée de chacune
ous permettra de voir où vont les capitaux
ır nos fermes.

L'inventaire total moyen pour les 15 fermes
t de $13927.46. Aux Etats-Unis, en 1910, la
leur moyenne des fermes était de $6444.00
. F. Warren, Farm Management). Nous
ublons donc le capital investi sur la ferme
ır nos voisins.

Comparons maintenant les valeurs engagées dans quelques départements et leurs pourcentages avec ceux des Etats-Unis.

Tableau I.

	Province de Québec, 1923-24		Etats Unis, 1910	
	Valeur	%	Valeur	%
Capital foncier	$10353.	74.3	$5471.	85.
Mobilier civant	1868.	13.4	774.	12.
Mobilier mort	1609.	11.5	199.	3.
Constructions	4212.	30.	995.	15.

La grandeur moyenne en culture des 15 fermes dont il est ici question pour Québec est de 90½ arpents, tandisqu'aux Etats-Unis, elle était en 1910 de 75 âcres; l'évaluation à l'âcre aux Etats-Unis était donc en 1910 de $59.68 tandis que dans Québec, en 1923-24, la terre valait $67.87 à l'arpent. Le mal n'est donc pas tant dans la surcapitalisation du sol lui-même que dans celle des autres départements, comme la maison du cultivateur, les constructions et les machines dont il se sert.

Dans le comté de Livingston, N.Y. le pourcentage du capital investi sur la maison et les autres constructions nous est donné dans le tableau suivant (Cité de Warren, Farm Management), cela pour 578 fermes.

Tableau II.

Ferme de	Maison		Autres constructions	
30 âcres ou moins	$1494.	43%	$655.	19%
31 à 50 âcres	1000.	23%	681.	15%
51 à 100 âcres	1236.	18%	1091.	16%
101 à 150 âcres	1477.	14%	1408.	13%
151 à 200 âcres	1810.	13%	1900.	13%
plus de 200 âcres	2113.	9%	2552.	11%

La même comparison pour nos 15 fermes de Québec nous donne les chiffres suivants:

Tableau III.

Ferme de		Maison		Autres constructions	
60 à 70 arpents	(1)	$3850.	25.5%	$1222.	8.2%
70 à 80 "	(2)	1580.	14.4%	1436.	11.9%
80 à 90 "	(7)	1765.	11.8%	2559.	18.3%
90 à 100 "	(2)	1678.	14.5%	3309.	13.5%
100 à 130 "	(3)	1797.	13.7%	1843.	14.3%

Comparons maintenant le capital engagé dans les machines avec celui engagé dans le sol lui-même:

Tableau IV.

No.	Etendue cultivée	Valeur du sol	%	Valeur des machines	%
1	82.4 arpents	$2050.	17.5	$1740.	14.7
2	82.4 "	6073.	38.7	757.	4.8
3	61.3 "	6925.	46.	1075.	7.1
4	88.9 "	12585.	56.3	1471.	6.5
5	93. "	9157.	48.8	1715.	8.1
6	94.9 "	6884.	42.	1162.	7.
7	86.8 "	3165.	31.8	1698.	17.1
8	72.9 "	9175.	49.3	2159.	11.5
9	119. "	7200.	50.5	1327.	9.2
10	130.5 "	3000.	25.6	1168.	9.9
11	84.1 "	6422.	38.4	633.	3.7
12	85.3 "	4695.	32.4	1174.	8.0
13	80.4 "	4240.	35.	1784.	14.7
14	116.8 "	5600.	41.1	1292.	9.3
15	79. "	4963.	41.7	381.	3.2

Le professeur Warren dit qu'aux Etats-Unis le capital investi dans les machines ne dépasse pas 4% du capital total, sur les fermes ordinaires sauf pour les fermes à exploitation sucrière, où ce pourcentage va jusqu'a 22%. Nous n'avons ici que deux fermes dont le pourcentage de capital investi sur les machines est inférieur à 4%. Il faut admettre, il est vrai, une hausse considérable dans le prix des machines depuis quelques années, mais, dans bien des cas cependant, il est certain qu'on fait des déboursés trop considérables pour achat de machines que, malheureusement, on ne protège pas toujours suffisamen Que de fois ne serait-il pas plus avantageu pour le cultivateur de louer les machines do il a besoin plutot que d'en faire l'achat, su tout lorsque ces machines ne doivent travaill que quelques heures par année. Tels pa exemple une lieuse à blé d'Inde, une moi sonneuse lieuse, un épandeur à fumier, u épandeur à engrais chimiques, un moteur essence, une batteuse à grain sur une peti exploitation à culture variée. Ces six mac ines représentent une valeur de $900. à $100 et, sur une ferme de 90 arpents, aucune d'ell ne travaillera plus de 30 heures par anné La dépréciation moyenne de ces machin (Minnesota, Bul. 117) est de 9% par anné en supposant qu'on en prenne bien soin, c qui fait, pour les six, une dépréciation a nuelle de $100. En supposant qu'elles n travaillent que trente heures chacune, il es certain u'on pourrait les louer pour moi de $100.

Effets de la mauvaise répartition de capitaux sur le résultat financier d l'exploitation agricole.

De la mauvaise répartition des capitaux résulte un manque d'équilibre entre les di férents départements et, par suite, bien so vent des pertes financières. Le tableau donne une idée des rapports qui existent entr le capital investi dans chaque département e le profit qui en résulte.

Tableau V

Fermes No.	Vacherie		Poulailler		Ecurie		Porcherie		Bergerie		Produits généraux	
1	$1039.	8. %	$35.50	.2%	$619.	5.2%	$260.	2.2%	$117.	.9%	$734.	6.1%
2	2107.	13.3%	54.50	.2%	555.	3.5%	90.	.5%	113.	.7%	742.	4.6%
3	288.	2.5%	57.50	.3%	563.	4. %	85.	.5%	13.	.8%	761.	5. %
4	2506.	15.6%	7.25	.3%	729.	3.2%	——	——	——	——	1038.	4.6%
5	711.	3.7%	64.85	.3%	656.	3.5%	104.	.6%	72.	.4%	805.	4.2%
6	1809.	11. %	37.00	.2%	465.	2.7%	261.	1.5%	53.	.3%	1063.	6.5%
7	923.	9.3%	53.25	.5%	394.	3.9%	189.	1.9%	——	——	781.	7.7%
8	2134.	11.4%	——	—	410.	2.1%	235.	1.2%	——	——	1067.	5.7%
9	910.	6.3%	52.00	.3%	557.	3.8%	156.	.8%	122.	.8%	618.	4.2%
10	809.	6.7%	105.00	.8%	656.	5.5%	90.	.7%	——	——	723.	6.1%
11	718.	4.3%	446.30	2.7%	364.	2.1%	12.	.5%	——	——	983.	5.9%
12	817.	5.6%	24.25	.1%	786.	5.5%	163.	1.0%	215.	1.4%	1976.	13.1%
13	965.	7.9%	37.22	.2%	1078.	8.8%	165.	1.3%	124.	1.0%	1415.	11.7%
14	1146.	8.3%	54.00	.3%	896.	6.6%	160.	1.1%	61.	.4%	1087.	7.9%
15	1374.	11.5%	26.50	.2%	432.	3.6%	250.	2.1%	——	——	808.	6.7%
Moyenne	$1217.	8.7%	$70.37	.5%	$611.	4.3%	$148.	1.0%	$59.	.4%	$967.	6.9%

Tableau VI.

Profits et pertes des départements.

Ferme No.	Vacherie	Poulailler	Ecurie	Procherie	Bergerie	Prod. Génér.	Profit d'ensemble
1	$196.58	$ 8.23	-$291.29	-$116.47	$21.16	$124.96	-$829.46
2	713.04	36.44	142.19	82.14	-16.32	-141.68	-178.66
3	130.08	62.17	20.91	-53.84	10.60	-5.17	-476.20
4	1138.73	——	-261.38	——	——	-327.96	-1010.27
5	55.23	17.84	35.43	-93.46	-26.94	-231.44	-1471.73
6	626.54	62.52	94.32	-97.24	-39.65	67.33	-339.30
7	-106.20	-0.19	-200.31	-71.43	——	480.97	-429.62
8	194.32	——	-18.53	-266.18	——	-334.32	-1652.68
9	536.52	66.35	5.16	-146.45	29.98	630.21	-261.14
10	338.22	122.05	-92.97	-6.83	——	-19.22	-626.60
11	-130.11	62.97	146.38	-22.10	——	133.45	8.04
12	187.62	35.44	224.19	49.03	-97.05	1598.75	1043.28
13	233.09	94.99	281.98	108.01	-52.92	13.46	239.52
14	423.48	97.05	90.62	-135.44	-69.22	-341.08	-770.30
15	-521.97	19.30	-1.37	-56.33	——	430.30	-699.12
Moyenne	$273.67	$45.67	$11.69	-$55.10	-$16.02	$139.26	-$496.96

Le tableau ci-dessus montre les profits ou pertes de chaque départment et le profit ou la perte réalisé dans l'ensemble de l'administration. (Le signe - indique une perte).

Les chiffres ci-dessus ne sont pas de nature à réconforter les pessimistes en agriculture; cependant, pour être véridique, il faut ajouter que le profit net dont il est ici question (qu'il soit affirmatif ou négatif) est celui obtenu après avoir prélevé de 5% sur le capital investi et un salaire de $2.00 par jour à son propriétaire. Disons aussi en passant que des 15 fermes 14 sont exploitées par leur propriétaire, l'autre étant louée.

Le tableau VII fera ressortir le pourcentage des profits et pertes de chaque département en comparaison d'un inventaire moyen de chacun pour les 15 fermes.

Tableau VII

Départements	Inventaire	Profits %	Pertes %
Vacherie	$1217.	22.4	
Poulailler	70.	22.4	
Ecurie	611.	1.9	
Porcherie	148.		37.1
Bergerie	59.		27.0
Produits généraux	967.	14.4	
Total	$13927.		3.5

L'écurie devrait figurer sans profit ni perte et être un département de transition; si nous arrivons ici avec des profits, c'est grace au travail extérieur des chevaux en hiver.

Il a été dit plus haut que le système de culture qui semble le plus avantageux pour nous est celui d'une production générale, avec, ligne d'à côté, une production spéciale dans laquelle un léger surplus de capital est engagé: D'après le tableau VI, on voit que trois fermes seulement arrivent, à la fin de l'année, avec un profit net; chacune de ces trois fermes se livre, à part la production générale, à une spécialité plus ou moins importante. La ferme No. 11 fait de l'aviculture sur une assez haute échelle; la ferme No. 13 réalise des profits assez considérables avec ses chevaux qui passent l'hiver aux chantiers, et enfin la ferme No. 12 a comme spécialité la production du grain de semence qui chaque année lui rapporte de gros profits.

Après toutes ces considérations, une réflexion se pose: Est-ce que nous ne sommes pas portés à exagérer lorsqu'il s'agit de l'amélioration d'une ferme et est-ce que nous songeons bien toujours si les déboursés que nous conseillons pourront surement et assez tôt être compensés par les profits qui en devront résulter? Il y aurait un travail considérable à faire dans le domaine de l'économie rurale et la crise actuelle ne nous fait-elle pas voir tous les jours que c'est pour avoir manqué de sens économique que tel ou tel cultivateur se voit acculé à la banqueroute.

BIBLIOGRAPHIE

COURS D'AGRICULTURE, par M. Bertrand, professeur de sciences naturelles et d'agriculture à l'Ecole normale de Malonne (Belgique). Onzième édition, en deux volumes cartonnés, de, respectivement, 340 et 270 pages, avec très nombreuses illustrations et dessins dans le texte.

Imprimerie J. Duculot, libraire-éditeur, à Gembloux, Belgique, année 1923.

Prix: 15 francs pour les deux volumes. S'adresser pour commande à "La Procure" Société Coopérative, 14 boulevard Ernest Mélot, Namur (Belgique).

Ce manuel général comporte donc toutes les notions d'agriculture enseignées aux élèves de l'Ecole normale de Malonne qui forme de futurs instituteurs destinés à l'enseignement dans les écoles primaires de Belgique.

Ecrit dans un style clair et précis, il témoigne de la part de l'auteur, lequel est en même temps professeur de sciences naturelles à Malonne, d'une connaissance aussi profonde que murie de celles-ci et de leur adaptation à tous les problèmes de l'agriculture scientifique ou pratique. Tous les chapitres de l'agriculture qu'un instituteur placé dans un milieu rural est obligé de traiter au cours de son enseignement ou de comférences de vulgarisation agricole, y sont traités fort substantiellement.

L'ouvrage est divisé en quatre parties. Dans les 22 chapitres de la 1° partie, il est traité, successivement, du sol (propriétés physiques, chimiques et biologiques), des améliorations foncières, moteurs et instruments employés dans le travail du terrain, du fumier, des engrais chimiques et amendements, de l'amélioration des plantes et semailles, de la récolte des produits, des assolements ou rotations.

La deuxième partie est entièrement consacrée à l'arboriculture fruitière, telle qu'elle se pratique en Belgique.

Nous trouvons réunies dans la troisième partie de l'ouvrage des notions d'hygiène de l'habitation rurale, d'aménagement du logement des animaux, d'alimentation rationnelle, de laiterie, d'extérieur du cheval et d'aviculture.

Enfin, dans la quatrième partie, une place très importante est faite aux cultures potagères, fort en honneur dans un pays à population très dense comme la Belgique, et un dernier chapitre est réservé à la comptabilité agricole.

Ce qui rend la lecture de ce manuel particulièrement attrayante, surtout pour les personnes qui ne sont pas spécialisées en agriculture, ce sont les nombreuses photogravures, dessins et graphiques qui en interrompent le texte. D'autre part, tous les chapitre qui le comportent sont suivis d'exercices pratiques ou de petits problèmes se rapportant à la matière enseignée.

Ecrit spécialement pour les conditions agricoles qui prévalent en Belgique, bien des parties de l'enseignement que renferme cet ouvrage se trouveraient naturellement dépaysées au Canada. Cela n'empêche pas qu'il soit des plus recommandables à tous les agronomes qui s'occupent d'enseignement agricole vulgarisé, soit dans les écoles rurales ou à l'occasion de conférences. Ils y trouveront des inspirations et des méthodes utiles. D'autre part, en raison de son prix fort modique, lorsqu'exprimé en piastres, cela vaudrait déjà la peine de l'acheter rien qu'à titre de documentation en matière d'agriculture comparée.

Le fait que ce manuel en est déjà rendu à sa onzième édition témoigne bien de l'estime dans laquelle il est tenu dans son pays. A l'occasion nous nous chargerons de le faire venir pour ceux qui nous en feront la demande.

H. M. N.

ACHAT DE LIVRES

Nous rappelons aux membres de la C.S.T.A. les grands avantages dont ils jouissent en passant par l'intermédiaire du Sécrétaire général de la société, Monsieur Fred. Grindley, P.O. Box 625 à Ottawa, pour l'achat de leurs livres techniques. Outre une remise de 20% sur le prix du Catalogue pour toutes les maisons d'édition mentionnées, l'expédition, par malle ou par express, se fait gratuitement.

ACTIVITES DES SECTIONS.

Section de Montréal

L'assemblée annuelle de la section de Montréal de la C.S.T.A. a eu lieu, le samedi 9 mai, au Cercle Universitaire en cette ville. Le diner causerie organisé à cette occasion fut particulièrement brillant et animé. Monsieur Antonio Grenier, Sous-Ministre du Département de l'Agriculture de la Province

Québec, invité à titre d'hôte d'honneur, assistait. Le conférencier du jour fut Monieur L. Philippe Roy, chef du Service de la rande Culture, au même Département.

Le président de la section de Montréal, . H.-M. Nagant, commença par remercier nom de tous les membres, Monsieur Anio Grenier, pour l'honneur et le réel plair qu'il leur faisait en voulant bien s'arrach à de nombreuses et pressantes occupations our prendre part à cette réunion. Faisant suite ressortir l'estime générale dont jouit onsieur Grenier grâce à ses éminentes qualés d'administrateur, il exprima, de la part tous les techniciens agricoles de la Provce, le vœu de le voir longtemps encore cuper les importantes fonctions de Sousinistre, pour le plus grand bien de l'Agriulture.

Après celà, ce fut le tour du conférencier, onsieur L. Philippe Roy, Chef du Service la Grande Culture, au département provcial, d'être présenté comme l'un des collarateurs dont Monsieur Grenier avait su des us judicieusement apprécier l'intelligence, sprit d'initiative, et le talent de réalisation atique. Au cours d'une causerie de plus ne heure, Monsieur L. Philippe Roy développa une étude fort substantielle, portant mme titre: "Systèmes de culture et rotaons adaptés aux conditions de la Province Québec."

Comme il nous serait impossible de rendre stice à ce travail très documenté et plein considérations pratiques, en nous bornant l'esquisse de ses divisions principales, nous éférons nous abstenir. Mais nous compas bien que, pour le bénéfice des lecteurs i n'ont pas assisté au dernier diner causerie, onsieur Roy voudra le publier, sous une rme condensée, dans un des prochains méros de la Revue.

Ce fut Monsieur Lucien Therrien, Agronie officiel du Comté de Missisquoi, et an- n élève du Conférencier, qui le remercia nom de l'Association.

Pour cloturer cette belle séance, Monsieur ntonio Grenier adressa des remerciements la section de Montréal, la félicita de son ivité et fit l'éloge du travail des agronomes général.

Enfin, il fut procédé à l'élection du bur pour l'année qui prend cours au mois de n.

Sur proposition de Monsieur Arthur Lamarre, Agronome du Comté de Laprairie, appuyé par M. W. Houde, le bureau actuel, composé de M. H.-M. Nagant, Président; R. Rousseau, Vice-Président, et Gustave Toupin, Sécrétaire-Trésorier, fut réélu.

D'autre part, Messieurs Elzéar Montreuil et M. H.-M. Nagant furent désignés comme délégués officiels de la section de Montréal à la convention générale de la C.S.T.A. qui a lieu au mois de juin à Edmonton.

Le diner causerie du 9 mai dernier réunissait 34 convives.

H.M.N.

FEU J. E. THIFFAULT

Le 27 avril dernier, le corps agronomique de la province de Quebec était plonge dans le deuil par la disparition presque subite de Mr. J.-E. Thiffault, agronome officiel de Labelle.

J. E. Thiffault

J.-E. Thiffault naquit à St-Stanislas de Champlain le 24 décembre 1898. En 1921 il sortait de l'Institut Agricole d'Oka avec le titre de Bachelier en Agriculture et entrait bientôt au Service de l'Horticulture de Quebec comme instructeur. En fevrier 1922 il fut nommé assistant-agronome pour le comté de Beauce et en mars 1923 il etait promu agronome officiel de Labelle, avec résidence à Nominingue, en remplacement de Mr. J.-R. St-Arnaud transféré à St-Jean.

L'activité considérable qui caractérise la fonction de tout agronome officiel n'etait pas de nature à corriger les défauts d'une santé délicate et le 24 avril dernier, il etait terrassé par une péritonite aigue qui l'emportait trois jours après, laissant pour le pleurer son épouse (née Bertha Lafontaine) et un jeune fils.

Ses funérailles ont eu lieu le 30 avril dernier à St-Stanislas, sa paroisse natale, au milieu d'un grand concours de parents et amis parmi lesquels l'on pouvait compter plusieurs agronomes confrères, presque tous membres de la Societé.

Les cultivateurs de la région de Nomininguе perdent en Mr. Thiffault un excellent serviteur de leur cause et le Ministère de l'Agriculture l'un de ses plus fidèles officiers. Son travail agronomique ne demeurera pas sans fruit et s'il n'a pas eu le plaisir de les récolter lui-même, l'agriculture de cette région saura sans doute en profiter.

A son épouse, à son jeune fils et à ses vénérables parents, *La Revue Agronomique* se faisant l'écho de toute la Société des Ingénieurs Agricoles, offre l'expression de ses plus vives sympathies.

O.C.

NOUVELLES DE NOS MEMBRES

Sous-ministre adjoint à Ottawa

Nos plus vives félicitations s'adressent a Docteur A. T. Charron dont la nominatio comme Sous-ministre adjoint au Départeme fédéral de l'Agriculture à Ottawa vient d'êt confirmée officiellement.

Quoique jeune encore, le Docteur Charro est déjà un vétéran du mouvement à base r ellement scientifique qui s'est manifesté da l'Agriculture de notre Province. La bel carrière qu'il a fourni jusqu'ici est trop co nue de tout le monde pour qu'il soit beso d'en retracer les étapes; elle est un gage l'influence féconde que le premier titulai des nouvelles fonctions crées à Ottawa manquera pas d'exercer dans la voie de no veaux progrès pour l'Agriculture du pays

La section de Montréal, dont fait part le Docteur Charron, se sent particulièreme honorée de cette nomination.

A. T. Charron

THE FIFTH ANNUAL CONVENTION.

In many ways the recent Convention of the Canadian Society of Technical Agriculturists, held at the University of Alberta, was the most successful in the history of the organization. The attendance—considering the remoteness of the place of meeting—was large, the weather was perfect (in contrast to Saskatoon in 1923), enthusiasm ran high, reports of standing committees showed very definite progress, the advanced lectures were of a high order, and discussion was keen throughout the meetings. Nothing better could have been desired.

Western hospitality was clearly exemplified in the arrangements made at the University. The residences and lecture rooms were thrown open and everything possible was done to ensure the comfort of the visitors. The meetings of the Canadian Seed Growers' Association during the three days preceding the C.S.T.A. Convention helped to increase the attendance at both gatherings without any overlapping.

Dean E. A. Howes, the newly elected President of the C.S.T.A., presided at all business meetings. An effort will be made to outline, in the following pages, the most important features of the Convention:

REPORTS OF STANDING COMMITTEES

AFFILIATIONS:

Dr. W. H. Brittain, Chairman of this Committee, submitted a report stating that during the past year the C.S.T.A. had become affiliated with the Royal Society of Canada and the British Association for the Advancement of Science. Following upon a previous affiliation with the American Association for the Advancement of Science in 1921, it was considered that the C.S.T.A. had now received adequate recognition in Canada, Great Britain and the United States.

The Committee recommended that steps be taken "to encourage the adhesion of organizations with similiar aims to our own, as affiliated Societies of the C.S.T.A.", and clauses were embodied in the revised Constitution and By-laws to provide for this.

GRADUATE STUDIES:

The report of the Committee on Graduate Studies is published elsewhere in this issue.

RESEARCH:

See elsewhere in this issue.

EDUCATIONAL POLICIES

The report of this committee, presented by Dr. L. S. Klinck, chairman, aroused keen discussion and it was apparent that many of the recommendations made were of a controversial nature, and that the report should not be adopted in its present form.

It was considered that the best way to stimulate discussion would be to publish the report in *Scientific Agriculture*, and President Klinck expects to submit it for publication in an early issue.

Definite progress is being made by all these committees, and it is unfortunate that the membership body does not show greater appreciation of the work the Society is doing in this way.

AMENDMENTS TO CONSTITUTION AND BY-LAWS.

Approved by the Convention after proposal by the following committee: D. G. Laird, F. W. Bates, G. M. Stewart, L. P. Roy and L. C. Raymond. (*Amendments are printed in italic.*)

Constitution.

ARTICLE 3: MEMBERSHIP.

"There shall be *four* classes of membership—Regular, Associate, *Student* and Honorary."

Section 3, Article 3, defines this new class of member as follows: "*Student Members shall be those who are senior students pursuing a degree course at an agricultural college of recognized standing.*

ARTICLE 7: MEETINGS.

"There shall be an annual Convention of the Society and, *except under special circumstances*, this shall be held alternately in eastern and western Canada.

ARTICLE 12: AFFILIATED SOCIETIES. (New)

Any society having as one of its objects the advancement of any branch of agricultural science may be admitted as an affiliated society, as provided in the by-laws.

Fifth Annual Convention of C.S.T.A.

University of Alberta, Edmonton

FRONT ROW (left to right)—L. T. Chapman, H. G. L. Strange, J. C. Noble, J. M. Evvard, H. A. Craig, F. H. Grindley, H. Barton, (*retiring President*). E. A. Howes, (*President*), C. A. Zavitz, V. W. Jackson, J. Macgregor Smith, K. W. Gordon.

SECOND ROW—H. W. Scott, F. W. Bates, G. G. White, F. W. Brodrick, A. W. Mason, ————————, J. R. Higgins, G. E. DeLong, J. E. Bowstead, L. P. Roy, W. R. Leslie, A. E. Palmer, C. W. Leggatt, G. G. Moe, W. D. Albright, ————————.

BACK ROW—James Murray, S. G. Carlyle, A. Newman, W. H. Robertson, W. D. Hay. C. Tice, E. H. Buckingham, ————————, E. G. Bayfield, C. T. Tapp, L. E. Kirk, ————————, D. G. Laird, G. P. McRostie, ————————, C. H. Goulden, C. Sweet, R. Broadfoot, P. R. Talbot, W. A. Thomson.

BY-LAWS

By-law 5: Fees (Completely Amended).

1.* *All regular members, with the exception of those who make application for membership within one year after graduation, shall pay an initiation fee of five dollars.*

2. *Regular and Associate members shall pay an annual fee of six dollars.*

3. *Student members shall pay an annual fee of three dollars.*

4. One dollar of each fee shall go to the local branch.

All fees shall be payable either to the local secretary or to the general secretary.

* Clause 1 shall become effective on January 1, 1926.

By-law 9: Affiliated Societies.

1. *Application for affiliation must be made in writing to the Dominion Executive and submitted for approval at the annual convention.*

2. *Affiliated Societies may hold meetings during the annual convention and programmes of such meetings will be included in the Convention programme. These affiliated societies shall also have the privilege, at the discretion of the Editorial Board, of using the official organ for the publication of papers, addresses, etc.*

A completely revised Constitution and By-laws will be sent to each member about September 1st, embodying the foregoing changes.

It will be noted that no change was made in the present fee of $6.00. It was realized that a $5.00 fee would be much more desirable, and may be possible in a year's time, but the common delinquency in paying fees and the fact that revenue would be reduced by $750, made it impossible to consider any reduction this year. The present operating expenses of the Society (including the magazine) are approximately $15.00 per member, and it was considered that $6.00 was not an unfair share of this for each member to bear.

It is also to be noted that, in addition to the annual fee, an initiation fee of $5.00 becomes effective on January 1, 1926. In the meantime anyone who is eligible can join for $6.00. This provision was made so that those who are friendly to the organization, but have found the $10.00 entrance fee too high, may now have a chance to join at a lower fee. By January 1st, all such men should be members, and after that date no further campaigning will be necessary among the older graduates. They are not likely to join at $11.00 if they would not join at $6.00. Future campaigns will therefore be confined to graduating classes. For these men, a student membership clause is provided at $3.00 per year, and they are not required to pay any initiation fee if they join within one year after graduation.

Provision is made in the amendments for affiliated societies.

NOMINATIONS.

The following is the personnel of all Committees for the year ending May 31, 1926:—(Chairman in all cases is named first).

Research: G. P. McRostie, J. F. Snell, J. M. Swaine, H. Barton, E. S. Archibald.

Agricultural and Educational Policies: L. S. Klinck, H. S. Arkell, H. A. Craig, M. Cumming, Charles Gagné, F. C. Harrison, E. A. Howes, W. C. McKillican, Father Leopold, J. B. Reynolds, W. J. Rutherford.

Marketing Education: A. A. MacMillan, C. W. Baxter, J. F. Booth, W. A. Brown, F. M. Clement, J. A. Ruddick, C. P. Marker, S. E. Todd, A. Leitch, J. B. Cloutier, Dan Johnson, J. K. King.

Graduate Study: G. G. Moe, E. S. Archibald, G. R. Bisby, W. H. Brittain, M. Champlin, R. D. Colquette, B. T. Dickson, C. A. Fontaine, L. H. Newman, R. Newton.

Affiliations: L. H. Newman, A. Gibson, T. G. Major.

Finance—G. C. Creelman, Gus Toupin, G. M. Stewart.

Membership—C. A. Zavitz, L. E. Kirk, P. Stewart.

Ballots—L. C. McOuat, J. G. Crawford.

Executive Council—E. A. Howes, G. C. Creelman, L. P. Roy, P. Stewart, C. A. Zavitz, A. R. Ness, H. M. Nagant, L. H. Newman.

Associate Editors—E. S. Archibald, J. B. Spencer, J. M. Swaine.

Editorial Board—Elsewhere in this issue.

Representative on Council of A.A.A.S.—(To be appointed).

Auditors—G. LeLacheur, A. E. McLaurin.

Scholarships— G. C. Creelman, L. H. Newman and R. Harcourt.

Progress—L. H. Newman, H. R. Hare, W. H. Brittain.

RESOLUTIONS

Submitted by the following Committee: R. Newton, R. Summerby, A. W. Mason and V. W. Jackson.

1. Resolved that the hearty thanks of the members and delegates assembled in the Fifth Annual Convention of the C.S.T.A. be tendered:
   (1) To the Dominion Department of Agriculture for its effective cooperation and assistance, especially in regard to the arrangements for advanced lectures at the Convention.
   (2) To the C.S.G.A. for their cooperation in the arrangement of the date and place of meeting, a very important factor in the attendance and general success of the Convention. The division of the program between the two organizations this year in such a way as to avoid overlapping, has been particularly advantageous.
   (3) To the Alberta Provincial Department of Agriculture for the printing of programs and other general assistance, as well as for the hospitable welcome to the Province of Alberta which has been extended to the Convention.
   (4) To the University of Alberta for placing all its resources, including the hospitality of its residences, at the service of the Convention.
   (5) To the various Standing Committees, and especially to their chairmen, for the further valuable contributions they have made to the progress of various important interests of the Society as a result of their work during the past year.
   (6) To the Alberta Branch of the C.S.T.A. for valuable co-operation in the arrangement of the Convention programme, and for providing entertainment at the dinners on June 25th and 26th.
2. That short abstracts or notices of Canadian publications, provincial bulletins, or scientific articles relating to agriculture, such as appeared in The Agricultural Gazette and now discontinued, be published in *Scientific Agriculture*, and that local branches be responsible for collecting and forwarding to the General Secretary such bulletins and articles or abstracts thereof.
3. Resolved that the C.S.T.A. take active steps to organize a Bureau of Employment for the purpose of, (a) putting graduates in touch with men who have positions to offer; (b) putting men who have positions to offer in touch with graduates, and (c) enlarging the field in which agricultural graduates may be usefully employed.

FELLOWSHIP

The C.S.T.A. Fellowship which has been awarded each year for professional distinction, was this year awarded to Dr. C. A. Zavitz, Professor of Field Husbandry at the Ontario Agricultural College, Guelph.

1926 CONVENTION

On the invitation of the Dominion Department of Agriculture, and after the receipt of telegrams from the Mayor of Ottawa and the Secretary of the Ottawa Board of Trade, it was decided to hold the 1926 Convention in the Capital. This will be the first Convention held there since the Organizing Convention in 1920.

VISIT TO E. P. RANCH

At the close of the Convention, about forty members left Edmonton on the night of June 26th, and on the following day were motored from Calgary to the Prince of Wales' ranch, 69 miles southwest of that city. The weather was perfect for such an outing, and the cordial reception tendered by Prof. W. L. Carlyle, Manager of the ranch, was fully appreciated. Luncheon was served in a cool grove of trees, and during the afternoon as much of the live stock was exhibited as was possible.

It was a memorable occasion. Many photographs were taken and some of these will appear in an early issue of the magazine.

ADVANCED LECTURES

The series of advanced lectures, provided through the courtesy of the Dominion Department of Agriculture, were of an extremely high order. Manuscripts of most of these will be available for later publication in *Scientific Agriculture*.

ATTENDANCE

During the Convention ninety-three members registered—47 from Alberta, 6 from British Columbia, 9 from Manitoba, 15 from Ontario, 5 from Quebec and 11 from Saskatchewan. The following is an alphabetical list:—W. D. Albright, Beaver Lodge, Alta.

D. H. Bark, Brooks, Alta.; H. Barton, Macdonald College, P.Q.; F. W. Bates, Regina, Sask.; E. G. Bayfield, Claresholm, Alta.; J. E. Blakeman, Winnipeg, Man.; J. E. Bowstead, Edmonton, Alta.; R. Broadfoot, Winnipeg, Man.; F. W. Brodrick, Winnipeg, Man.; W. R. Brown, Edmonton, Alta.; G. F. H. Buckley, Edmonton, Alta.; E. H. Buckingham, Calgary, Alta.: T. G. Bunting, Macdonald College, P.Q.

S. G. Carlyle, Edmonton, Alta.; M. Champlin, Saskatoon, Sask.; L. T. Chapman, Lacombe, Alta.; A. E. Clarke, Edmonton, Alta.; G. H. Clark, Ottawa, Ont.; T. O. Clark, Edmonton, Alta.; H. A. Craig, Edmonton, Alta.; N. Curtis, Edmonton, Alta.

G. E. DeLong, Lacombe, Alta.; H. A. Derby, Edmonton, Alta.; R. A. Derick, Brandon, Man.

W. H. Fairfield, Lethbridge, Alta.; J. Ficht, Edmonton, Alta.; H. J. M. Fiske, Edmonton, Alta.; S. G. Freeborn, Calgary, Alta.; J. R. Fryer, Edmonton, Alta.

D. H. Galbraith, Vulcan, Alta.; S. H. Gandier, Claresholm, Alta.; K. W. Gordon, Saskatoon, Sask.; C. H. Gouden, Winnipeg, Man.; F. H. Grindley, Ottawa, Ont.

T. J. Harrison, Winnipeg, Man.; W. D. Hay, Lethbridge, Alta.; J. R. Higgins, Calgary, Alta.; E. S. Hopkins, Ottawa, Ont.; E. A. Howes, Edmonton, Alta.

V. W. Jackson, Winnipeg, Man.; J. T. Jansen, Ottawa, Ont.

A. T. Kemp, Olds, Alta.; L. E. Kirk, Saskatoon, Sask.; L. S. Klinck, Vancouver, B.C.

D. G. Laird, Vancouver, B.C.; C. W. Leggatt, Calgary, Alta.; W. R. Leslie, Morden, Man.; A. J. Logsdail, Kemptville, Ont.

W. T. Macoun, Ottawa, Ont.; A. J. Mann, Summerland, B.C.; C. P. Marker, Edmonton, Alta.; W. M. Martin, Edmonton, Alta.; A. W. Mason, Guelph, Ont.; G. D. Matthews, Indian Head, Sask.; V. Matthews, Scott, Sask.; G. G. Moe, Vancouver, B.C.; J. Murray, Medicine Hat, Alta.; A. A. MacMillan, Ottawa, Ont.; G. P. McRostie, Ottawa, Ont.

F. H. Newcombe, Vegreville, Alta.; A. Newman, Lethbridge, Alta.; L. H. Newman, Ottawa, Ont.; J. D. Newton, Edmonton, Alta.; R. Newton, Edmonton, Alta.; J. C. Noble, Regina, Sask.

A. E. Palmer, Lethbridge, Alta.

L. C. Raymond, Macdonald College, P.Q.; F. H. Reed, Lacombe, Alta.; P. E. Reed, Regina, Sask.; T. F. Ritchie, Ottawa, Ont.; W. B. Roadhouse, Toronto, Ont.; W. H. Robertson, Victoria, B.C.; L. P. Roy, Quebec, P.Q.

J. P. Sackville, Edmonton, Alta.; H. W. Scott, Sedgewick, Alta.; W. H. Snelson, Brooks, Alta.; J. Macgregor Smith, Edmonton, Alta.; W. Southworth, Winnipeg, Man.; W. J. Stephen, Lethbridge, Alta.; G. M. Stewart, Calgary, Alta.; P. Stewart, Ottawa, Ont. H. G. L. Strange, Fenn, Alta.; E. H. Strickland, Edmonton, Alta.; R. Summerby, Macdonald College, P.Q.; C. Sweet, Ottawa, Ont.

P. R. Talbot, Edmonton, Alta.; C. Tapp, Calgary, Alta.; W. A. Thomson, Pense, Sask.; C. Tice, Victoria, B.C.; M. P. Tullis, Regina, Sask.

G. V. VanTausk, Edmonton, Alta.

G. G. White, Regina, Sask.

C. A. Zavitz, Guelph, Ont.

THE AUGUST ISSUE

Owing to the fact that the present issue has been confined to a report of the Annual Convention, many features have had to be omitted, including the activities of local branches, personal items, etc. These will be resumed in the August issue, which will be the last of the present Volume. It will also contain a complete author and subject index for Volume V, and several interesting articles. Volume VI, will begin with the September issue.

While numerous suggestions for improving the magazine were made at the Edmonton Convention, the Editor will always appreciate helpful criticism and will do everything possible to meet members' wishes in the matter of editorial policy.

Report of the General Secretary.

FRED H. GRINDLEY

Presented at the Fifth Annual Convention, Edmonton, Alta., June 24th, 1925.

On the occasion of our fifth birthday as an organized body it is gratifying to look back upon the period of development through which we have passed and to assure the members at the outset of this report that we are numerically and financially stronger than at any previous time in our history.

Five years ago we organized at Ottawa with 417 charter members. We had no local branches, no prospect of an official organ and no money. All the fees from charter members had been spent on the organizing convention and we were forced to adopt a straight annual fee of $10.00 in the hope that it would provide us with sufficient funds to cover operating expenses. Two obstacles then faced the Society unexpectedly—the first one in July 1920, when an anticipated Dominion grant of $2500 failed to materialize, and the second one in July 1921 when the publication of our official organ was indefinitely suspended by the Industrial and Educational Publishing Company of Gardenvale, P.Q.

It is not my intention to review the intervening years. That does not come within the scope of an annual report. Today we have 747 members; we own, edit and publish our own magazine, distributing it free to every member; we have organized local branches in every province, which are financed by the parent body; and we have a surplus of over $1500 at our disposal.

Had no more than the foregoing been accomplished the members must have been eminently satisfied. But during that period of organization and development much more has been done. Five annual conventions and innumerable local branch meetings have been held, bringing the members together and helping to effect that co-ordination of effort which is so important; affiliations with national and inter-national bodies have given the Society recognition in this and other countries; the distribution of our magazine to practically every country in the world has been a tremendous publicity factor; the work of our Standing Committees has brought together a fund of useful information and the members owe to these Committees a great debt of gratitude; the wholesaling of agricultural books has provided a distinct membership privilege. And yet there remain, and always will remain, those who see no need for the Society, who five years ago said it would not survive twelve months and who certainly have done little to prevent the occurrence of such a catastrophe.

MEMBERSHIP: During the past year it has been necessary to remove the names of 61 members, either on account of resignation or for non-payment of fees. Three members have been lost through death—Reginald Charles Treherne who died at Ottawa on June 7th, 1924, Joseph E. Thiffault who died at Nominingue, P.Q. on April 27th 1925, and Samuel Judson Hetherington who died at Madison, Wis., on May 3rd, 1925. Seventy-seven new members have been accepted, of whom 15 were former members of the Society. The membership of the Society, therefore, increased during the year from 734 on June 1st, 1924 to 747 on June 1st, 1925.

Much of the credit for the enrolment of members is due to Dr. G. C. Creelman who, as Chairman of the Membership Committee, organized and conducted a membership campaign during the latter part of 1924, in co-operation with the General Secretary.

The present distribution of membership by locals is as follows:—

Alberta 64, British Columbia 68, Manitoba 51, New Brunswick 3, Nova Scotia 31, Eastern Ontario 96, Western Ontario 98, Prince Edward Island 12, Macdonald 54, Montreal 56, Quebec 71, North Saskatchewan 34, South Saskatchewan 46, British and Foreign 34.

TEXT BOOK CLUB: Sales of agricultural books have decreased slightly during the year but a larger number of members have taken advantage of this membership privilege than during any previous year.

AFFILIATIONS: The report of the Committee on Affiliations will record affiliation with

the Royal Society of Canada and the British Association for the Advancement of Science. Affiliation with the American Association for the Advancement of Science was effected in 1921.

SCIENTIFIC AGRICULTURE: The official organ of the Society has been published regularly and promptly each month during the year. No change in editorial policy has been possible and most of the articles have been rather more technical than popular in their nature. During the past few months an attempt has been made to introduce a Forum in which members may express their opinions upon any agricultural problem, but apparently this is not going to receive enough support to justify its continuance. Commencing in the last issue (June, 1925) the Dominion Department of Agriculture has agreed to use 12 pages per year, at a nominal cost of $10.00 per page, for the publication of notes, news, summaries of experimental work, etc., and if Provincial Departments of Agriculture and Agricultural Colleges would agree to a similar arrangement it would be possible to increase the size of the magazine in order to provide all members with this very valuable information.

BOOTH AND BANQUET AT ROYAL WINTER FAIR: In an effort to increase membership and to give a new membership service, the Society rented and furnished a booth at the Royal Winter Fair, Toronto, in November 1924, and in co-operation with the O.A.C. Alumni Association, put on a banquet at the King Edward Hotel. The cost of the booth was hardly justified, and in future the banquet is probably all that will be continued.

LOCAL BRANCHES: There has been a noticeable increase in the activities of local branches and all, with the exception of Western Ontario, have held regular meetings during the year. Such meetings are vital if membership interest is to be maintained and the situation in Western Ontario, where the majority of non-members are to be found, is one which should be given careful study by the incoming Executive.

TRAVELLING: The General Secretary has done no travelling for the Society, outside of Ontario and Quebec, during the year.

STANDING COMMITTEES: Reports of all Standing Committees are being presented at this Convention.

OFFICE ACCOMMODATION & CLERICAL ASSISTANCE: As a result of a resolution passed at the Saskatoon convention in 1923 and considered further by the Dominion Executive Committee at Guelph in 1924, the General Secretary accepted an office from the Dominion Department of Agriculture on November 1st, 1924. Since that time, through an understanding with the Canadian Seed Growers' Association, these two organizations have employed a clerk-stenographer. This arrangement has given the C.S.T.A., at a cost not exceeding $35.00 per month, the clerical assistance which has always been so badly needed.

APPOINTMENT OF FRENCH SECRETARY: The position of French Secretary, which was temporarily disbanded in June 1924, was again filled on April 1st, 1925, by the appointment of Professor H. M. Nagant of La Trappe, P.Q., at a salary of $50.00 per month. This is not to be considered as an added overhead expense, the understanding being that unless the revenue to the Society resulting from this position amounts to $50.00 per month, the appointment will be cancelled.

FINANCES: A study of the financial statement may not appear particularly encouraging. Our surplus has increased from $1534.23 to $1611.81, a difference of $77.58. There is an item of revenue, however, amounting to $67.00 which belongs to next year so that our actual operating profit during the past year has been approximately $10.00.

This is not a cause for any worry. There is no particular reason why the Society should show any operating profit. If no deficit has to be faced there is nothing over which any member need be concerned. Our expenditures during any year could be slightly reduced, and often have had to be reduced, to meet decreasing revenue. During the past year expenditures for printing, for cuts, for postage and for stenography were increased with some justification. But these extra expenditures, which in all cases were comparatively small, could have been avoided if it had been necessary.

In an effort to avoid a serious financial slump through decreasing advertising revenue, a campaign which included the printing and distribution of a booklet entitled "Agricultural Products & Equipment" was undertaken early in 1925, with the result that

the present advertising situation is considerable more favourable than it was at this time last year.

There is now so much criticism of the $6.00 annual fee that a reduction to $5.00 appears to be imperative. Such a reduction would mean an annual decrease of $750.00 in our revenue, but I think it should be approved by the delegates at this convention. An initiation fee of $5.00 should be introduced, together with an annual fee of $5.00 but no graduate who joins the Society within twelve months of graduation should be required to pay the initiation fee.

It is possible that the $5.00 initiation fee should not become effective until January 1st, 1926 and that in the interval every eligible member should be admitted for the annual fee, if he wishes to join. Such a step may appear unfair to the present membership body but it may be a necessary one. The reduced entrance fee for a period of 5 months is not going to effect those who are opposed to the Society—they would not join at any price. It is going to attract only those to whom the $10.00 entrance fee has always been a barrier, but who are otherwise friendly to the organization. We need those men in the Society and they are not going to join while the entrance fee remains at $10.00, no matter how much reduction may be made in the renewal fees.

If the foregoing suggestions are put into effect and each local branch puts on a membership campaign, supplemented by a Dominion-wide campaign from the central office, it is quite possible for the Society to have 1000 members by the end of the calendar year.

THE FIFTH ANNUAL CONVENTION: Plans for the Fifth Annual Convention were started early in the calendar year and the thanks of the members are due to Professor J. P. Sackville and Professor J. Macgregor Smith of the University of Alberta, who as Chairman of the Programme and Entertainment Committees have been almost entirely responsible for the arrangement of the programme as it now stands. Acknowledgment is also due to the Dominion Department of Agriculture for financial assistance in connection with the series of Advanced Lectures and to the Alberta Department of Agriculture for printing the convention programmes.

The following official delegates have been appointed by the various local branches:

Alberta—J. P. Sackville, J. Macgrego Smith, G. M. Stewart.

British Columbia—D. G. Laird, W. H. Rol ertson, C. Tice.

Manitoba—F. W. Brodrick, V. W. Jackso W. R. Leslie.

E. Ontario—A. A. MacMillan, G. P. M Rostie, L. H. Newman, G. B. Rothwell, H Stewart.

W. Ontario—A. W. Mason, W. B. Roa house, C. A. Zavitz.

Prince Edward Island—B. F. Tinney.

Macdonald—H. Barton, T. G. Bunting, H Summerby.

Quebec—L. P. Roy.

N. Saskatchewan — M. Champlin, K. W Gordon.

S. Saskatchewan—P. E. Reed, W. A. Thom son.

Ballots for the annual election were mai ed to all members on April 10th, 1925 an were opened at Ottawa on May 1st. Th following official results were announced i the June issue of *Scientific Agriculture*:

President—E. A. Howes (acclamation).

Vice-Presidents — G. C. Creelman, L. H Roy.

Honorary Secretary—L. H. Newman.

Four hundred and thirty members voted.

The Society was represented at the annua meeting of the American Association for th Advancement of Science by Mr. Arthur Gil son and at the annual meeting of the Roya Society of Canada by the General Secretary.

There is little I need say in conclusion. T those members who are anxious that the Soc iety should continue its development and in crease its usefulness, there is no cause fo pessimism. We have already passed throug crises, financial and otherwise, which wer more serious than any we are likely to mee in the future. We are doing good work, giv ing useful service and steadily increasing ou membership. There is plenty of room fo extension of our activities to include an em ployment bureau, the publication of abstract and reviews, the building up of an agricul tural library, the development of an exten sive press service, etc. These extensions can not be considered under present circumstan ces and with existing facilities, but if every member would be proud of his Society and do all he could to help it, the days of greate usefulness and activity would soon arrive.

Presidential Address.

H. BARTON

Macdonald College, P.Q.

Five years is not a very long period, in terms of Agriculture. Most of us might regard it as sufficient to test an idea but not so many of us would consider it long enough to fully develop one of very far reaching importance. Five years ago the Canadian Society of Technical Agriculturists was but an idea. For five years it has been under test so we now should be able to form some opinion as to whether it is good or bad, worth while or not and whether the possible results to be obtained justify the further development necessary to secure them.

The test has been a severe one; a new type of society, therefore unaided by precedent and subject to skepticism and suspicion; a widely scattered prospective membership, a large section of which had formed no society predilections; trying times financially for men in professional agriculture and most adverse economic conditions generally; official support only as it could be justified and very limited financial assistance; these were some of the conditions under which the test was made.

The data are to be found in the annual reports of the secretary and other records of the society. The conclusion to be drawn I believe is indicated in the continued endorsement by nearly all the members and the further additions of new ones, numbering in all some seven hundred and fifty, and in the prestige the society commands, a prestige that is not fully appreciated by the members at large.

In my remarks at last year's convention I stated with approval that the first object of the society was to unite all workers in Scientific and Technical Agriculture for combined effort in promoting the efficiency of the profession in the service of Agriculture. That the C.S.T.A. has already done a great deal to bring the workers in Agricultural education together, cannot be questioned, and that there has been sufficient combined effort as a result of this association to indicate the possibilities is clearly evident to those who have had opportunity to observe it. It may be argued, however, that in the light of what might be done, more should have been accomplished. While in a measure I share this view, I feel impelled to point out that the greatest use of the machinery which such an organization provides can only be made when those for whom it is intended not only fully appreciate their own difficulties and the necessity for something of the kind to meet them but also are seized with some determination to use it. I do not wish to appear unduly critical nor is it my intention to deliver a curtain lecture but perhaps a little frankness in observations among ourselves will do no harm and may prove helpful. It appears to me that our experience and development as a profession will explain some of our peculiarities and account for some of the difficulties with which we are now confronted.

In the past twenty years, professional agriculture in Canada has had uninterrupted growth; the Dominion Department of Agriculture has grown enormously, the Provincial Departments of Agriculture have been created in their present form, colleges have sprung up in numbers, agencies and positions have multiplied more than tenfold and expenditure has mounted correspondingly and in accordance with the decreased value of money. Agricultural education has been broadcast and the profession has prospered. In our course of exploration we covered ground at a rapid pace and the going was fairly smooth and easy. How is it with us now? We are still broadcasting but it is apparent that progress is more difficult, conditions seem more adverse, the yield is smaller and the cost is high so people within and without the profession are asking us questions and making comments. Our policies and our methods have been successful in the past but it is suggested that we are too loathe to make any drastic changes in them. Adjustments of course are made but is it a fact that we are too much inclined to tread the beaten trail? If so, the further question naturally arises,

are we slaves to a system or is the system making slaves of us? Perhaps there is an element of both. We find ourselves committed to certain types of organization which have met the requirements in the past and from which it is difficult to depart. Our plans of operation, however, need not be so fixed; we ought at least to examine them critically in relation to situations that obtain, and above all our mental attitude collectively and individually should be such that no possibility will be ignored. Let us not be afraid to measure ourselves with this yard stick. The position of Agriculture demands it and can afford nothing less.

Farming in Canada today is not what it ought to be; the farmer's opportunity, while it is not nearly as bad as it is often represented, is not what we would like to see it but are our forces as well marshalled and as well directed in an effort to better that oportunity as we would like to see them? If not, why not and how? Mr. Arkell in his recent article in *Scientific Agriculture* refers to what he regards as some of our major issues and intimates that we need a carpenter to remodel some of our structure. Other suggestions have been made. In any case if revision is called for, we are all obligated and individually and jointly responsible.

In the past our major effort has been directed with a view to helping the farmer take advantage of what opportunity there was. As a rule we found it easy to help him, and first aid work was simple; we found him receptive and even curious; he was in need of simple help and the idea was new. Today the case is somewhat different; he needs help because he is in greater difficulty but his trouble is harder to treat. The factor of cost is more serious, the farmer himself is more able to do his own first aid work and has reason to expect a more highly skilled service from us. In relation to our work, both farm and farmer have shifted positions and I am not at all sure that professional agriculture has sufficiently oriented itself accordingly.

Our function is a twofold one, the establishing of knowledge and the humanizing of it. Naturally as our problems become more intricate our methods must become more thorough, more systematic, more technical, and more scientific. The technical and the scientific in agriculture are far from being e plored. There has not been time, money, n men so we have used what we had and wh we could borrow with the result that the has been considerable fallacious teaching an many things are still baffling us.

We are hearing more and more about hig ly trained men and scientific work. That a good omen. These are the keys with whic we must unlock much of the information w need, but let us not forget the fact that a accumulation of blank keys will not serv our purpose. It is necessary that they u lock something. We must not become in patient but I am sure we all want to feel tha the scientific and technical work carried o in the name of agriculture are really comin to grips with the issues over which we no seem to be stumbling. Whether rightly o wrongly there is some impression abroad tha among those whose work carries this respon sibility, there are some who seem content t feel that training and science may be recog nized as the end and not the means. Wisel enough we have been adding to our equip ment for better work but not a few conten that through this ambition for higher stand ards, Agricultural education in general ha suffered.

Much as we need more vital informatio we are already equipped with an appallin mass and while our efforts in disseminatio have been noteworthy as is evidenced by th changed position of farms and farmers, i must be amazing to everyone that there i still such a wide divergence between know ledge and practice. Everyone must realiz that despite imperfections any considerabl application of what is available would chang the whole aspect of farming. Is it the fa mer or his so-called instructor who is t blame? Obviously the answer could b argued both ways but the burden of proo rests upon us and after all we must tak farmers as we find them.

I use the word "humanizing" advisedly be cause I believe in the final analysis it ver aptly expresses what we are trying to do, re gardless of the form our efforts may take. I first suggested itself to my mind in relation t agricultural knowledge last year when I re ceived a communication from the America Association for the Advancement of Scienc in reference to the book by Dr. James Har vey Robinson entitled, "The Humanizing o

Knowledge". As no doubt some of you know, this little book is listed as the first of a number of the Workmen's Bookshelf, which represents a movement to bring knowledge and the workman's understanding more into line. That is precisely our problem as it applies to those who work on the land and I am going to take the liberty at this time to commend this book to members of the Agricultural profession. Dr. Robinson's pointed references to mankind's general indifference to scientific truth and the route by which new ideas must usually travel have interest for all of us and encouragement for some of us. The scientist who has accomplished so much by so successfully dehumanizing scientific investigation may get some inspiration that will help to make his work and himself better known and more appreciated. The danger of specialization with its separation of subjects into so many fragments that the relationship between them is ignored or forgotten is of special significance as applied to agricultural education because if I mistake not we are more and more focusing on the isolated factors, the natural lack of interest and apparent futility of which are very strongly suggested in the case of college teaching in how soon many of them are forgotten after the examination, and in the case of field work, in how casually they can be regarded by practical men.

The problem of presentation, if knowledge is to be successfully "democratized", may well engage our serious thought. A correspondent in a recent farm journal writes, "The human side of farm literature with which we were so familiar in pre-war days has given way to a collection of facts without imagination, human interest or sparkle of language." In this connection I should like to quote in part what Dr. Robinson has to say in reference to literature. "At present our books are not only too hard, they are too long. I might mention a dozen excellent works published during the past year which may have sold in quantities ranging from two to three thousand copies. Had they been judiciously condensed to half or a third their length they might not only have been made twice or thrice as clear and effective, but might have reached tens of thousands of readers. But this wide availability and appeal could only have been achieved at the cost of much additional labor on the part of the writers. To produce good little books easy to slip into one's pocket or bag, would require a red revolution among both authors and publishers. The sizes and weight of books, their paper and print, have their traditions like all else mortal."

"As for magazine and newspaper articles, they often afford ingenious and promising examples of the humanizing of knowledge. But they are too short, unless the theme be a mere item or is treated in a very general fashion. They are ephemeral, easily mislaid and hard to dig out of their foreign setting. It is consequently, almost impossible to preserve them for future use. We are apt to read them hastily, as we do all periodical material and then they are gone, leaving but a vague impression." "Writers will doubtless be found in increasing numbers who will be willing to spend twice the time on books half as large. And publishers may sometime recognize that the possibility of selling a hundred thousand copies at a dollar a copy may now and then outweigh the fair security of disposing of five thousand at three dollars and a half."

What shall we say of our books and bulletins, not to mention articles and lectures? Is conciseness a conspicuous feature; do they sparkle with language; are they so clear, so definite and so direct that their teaching is unmistakable, and are they likely to capture those for whom they were intended or are those for whom they were intended expected to capture them?

The intense earnestness, energy and industry for which so many of our profession are noted may in some measure account for the seeming barrier of individualism with which the society has to contend. It is more apparent than real however, because of the conditions and circumstances under which work must be done. I take it to be a function of the C.S.T.A. to disturb any undue self-complacency that may exist and to cultivate the urge for improvement; hence these observations and references, which I hope are prompted by a desire to both give and take. In any project of change we must take the human element for granted. Some one has said, "there is no pain like the pain of a new idea" and James Harvey Robinson says, "Of all human ambitions an open mind eagerly expectant of new discoveries and ready to remould conditions in the light of added knowledge and dispelled ignorances and misapprehensions, is the noblest, the rarest, and the most difficult to achieve."

Report of the Committee on Graduate Studies.

G. G. MOE, Chairman

University of British Columbia, Vancouver.

PART I.

At the conclusion of the last annual convention, it was apparent to the Committee that if they were to do the work for which they had been appointed, a definite programme would have to be formulated. In their opinion, such a programme should be of sufficient scope to cover the general question of post-graduate work in Agriculture, and should also indicate the line of thought of the Committee. (A copy of this tentative programme will be included as appendix A of this report).

It is at once apparent that such an outline of work cannot be completed in one year. Sound principles evolve slowly. If the greatest benefit is to be derived from the work of the Committee, the final results must be based on the gradual evolution and crystallization of ideas of all who are concerned with the question of graduate studies, rather than on a hasty summarization of random opinion. At the same time, the present Committee wish it to be clearly understood that they have no desire to impose a programme on the new Committee appointed by this Convention. The programme submitted has been drafted to serve simply as a guide to the Committee, in order that each phase of the question might be considered in its logical order and a proper proportion maintained.

In outlining its programme, the Committee has not overlooked the very real and immediate necessity of dealing with those questions referred to in last year's report, and which are the present concern of the employees of our administrative and educational institutions, namely, the attitude of the governing bodies of these institutions and departments to the following:—

(a) Facilities and Credit for Extra-mural Research.

(b) Where feasible the possibility of transference of work for a limited time to some institution of learning.

(c) Leave of absence for graduate study.

(d) Salary arrangements during such leav of absence.

These questions have been the first consid eration of the Committee, and the summar and conclusions from this study form the s cond part of this report.

In the report presented last year, referenc was made to the findings of the Committe which was appointed by the Universities Co ference to study the general question of pos graduate work in Canada. These finding have been adopted as the basis on which scheme of graduate work in Agriculture migh be formulated. It must be recognized tha Canadian conditions differ radically fro those prevailing in the United States, when a large number of students congregate an nually at the various institutions for pos graduate work. In Canada, unless the ou standing individuality of the work of som University, or College, or Department, a tracts students from other countries, the nu ber of graduate students will be governed, t a great extent, by the demand in Canada fo workers with advanced training. Until recen years this demand has not been great.

It must also be admitted that the limitation of finance and necessary equipment possibl present an obstacle in the way of any institu tion offering complete work leading to doctorate degree. The limitations of staff cannot be overlooked, and the Committe realized above all that the graduate work giv en must be on a par with that of the leadin Universities of Great Britain and the Unite States. However, the Committee felt reason ably certain that a systematic survey of ou resources, as regards the personnel and equip ment of our Universities and the Dominio Department of Agriculture, would reveal tha we already possess the material which may b utilized and correlated into a scheme su ficiently comprehensive to meet the presen needs of graduate work. No attempt here tofore has been made to study these resource from the point of view of Agriculture, or t estimate their collective worth.

As a preliminary to such a survey, a thorough investigation must be made of the fundamental thing in graduate studies, namely, the form and content of courses. Many who have taken, or are now taking, graduate work recognize the inadequacy of some of their undergraduate courses, and have had to spend time on preliminary work, which might have been covered in their bachelor's course. As to the work of the master's course, many diverse opinions are held. Some favour only practical agricultural subjects, some favour the pure sciences, while others hold to a middle course. The same holds true in regard to the doctorate courses. Furthermore the research problems of to-day require a different method of attack from those presented for solution a few years ago. More and more the worker trained in the pure sciences is being consulted and pressed into the service of agricultural research. As a result we have the occasional condition of an investigator, trained only in the pure sciences, working on Agricultural problems and finding no practical solution, because he lacks a fundamental knowledge of Agriculture. More frequently, the opposite occurs and we find investigators trained in agriculture, but lacking an adequate knowledge of the sciences, baffled by problems which can only be interpreted through the application of the theories and findings of pure science. A concrete example may illustrate this to advantage. One is fairly safe in assuming that at some time or other every experimental station in Canada has conducted experiments on "dates of seeding" in wheat, and the conclusion has been stated that, within reasonable limits, wheat should be sown as soon as the land can be worked in the spring. It is a compliment to the various investigators that the results from the various stations agree, but at the same time none of the experimentalists could offer an adequate explanation as to why the early seeding gave larger yields. It was left to the plant physiologist to demonstrate the reason and thus give the results a wider application, thereby eliminating the necessity for further work on this particular problem. The same holds true for many other problems. Valuable facts with local application have been demonstrated without the experimenter being able to offer a fundamental explanation. To-day we are compelled to be more and more concerned with the *why* of the problem in order that the results may have a more general application and duplicate experimentation thus avoided. In the opinion of the Committee, the foregoing explanations amply justify the necessity of first establishing a sound conception of what should constitute the basic work of the graduate courses before an enquiry can be made into the resources of our Universities and Colleges from the standpoint of promoting graduate work in Agriculture. With these explanations, the tentative programme is submitted for your consideration, in the hope that it will be adequately debated, and that the discussion may serve as a guide to the new Committee for the forthcoming year.

PART II.

Section A.

As previously stated, Section I of the outline has been the immediate concern of the Committee, and a very definite effort has been made to learn the attitude of the Universities and the Dominion and Provincial Departments of Agriculture, on these questions. The first section of this part of the report deals only with the Universities, the Colleges, or Faculties of Agriculture, and Provincial Departments of Agriculture; the second section summarizes the attitude of the officials of the Dominion Department.

The respective Canadian Universities were asked the following questions:—

(1) Would the graduate policy of your Institution favour the granting of credit towards the master's or doctorate degree for research performed under suitable supervision in one of the Dominion or Provincial Departments of Agriculture? If so, what amount of credit might be awarded.

(2) If extra-mural research is permitted by your institution, what form of supervision would your institution favour:—

(a) Complete direction from the Head of the Department in the University in which the student has registered, or:

(b) Direction by the officer in whose Department or Division the work is being conducted, subject to the approval of the Head of the Department in the University in which the student has registered.

Replies were received from the following Universities: Dalhousie, Mount Allison, the

University of New Brunswick, McGill, Queens, Toronto, Western University, and the Universities of Manitoba, Saskatchewan, Alberta and British Columbia.

DALHOUSIE UNIVERSITY:—It is the opinion of this Institution that a graduate in agriculture might proceed to the degree of master of science, and that his thesis work might be done under the proper supervision of a competent scientific man, not necessarily in the University.

MOUNT ALLISON UNIVERSITY—(Resolution of Faculty)—That research toward a master's degree may be permitted to be carried on under suitable supervision in one of the Dominion or Provincial Departments of Agriculture, the amount to be arranged in reference to the individual instance. The officer under whom the research is conducted shall keep in touch with the Head of the corresponding Department here, who shall be the authority in deciding the extent and value of the work done.

UNIVERSITY OF NEW BRUNSWICK—In the Departments of natural science, chemistry or physics, the course of study might be along agricultural lines. Candidates very seldom proceed to the degree in these Departments, owing to difficulties in extra-mural work in subjects which are largely experimental. Such research, as you suggest, would meet the requirements in a very satisfactory manner. Although we do not grant the doctorate degree, our facilities would be open to any student who wished to use our laboratories for special work under the instruction of the professors in charge. The work taken up might be along agricultural lines.

MCGILL UNIVERSITY:—Concerning the question of men in the Dominion Department of Agriculture obtaining credit for research problems towards a graduate degree, this matter is still under consideration by McGill University, and while opinion is favourable, the matter is not yet settled.

QUEEN'S UNIVERSITY:—No statement available at this time.

TORONTO UNIVERSITY:—No statement available at this time.

WESTERN UNIVERSITY:—No statement available at this time.

UNIVERSITY OF MANITOBA:—No statement available at this time.

UNIVERSITY OF SASKATCHEWAN:— Up to date no graduate has received the M.S.A. degree without being in residence at least a year. The residence requirement is one calendar year. It is possible that this requirement might be waived in cases where the candidate is working at an institution which has facilities that permit him to carry on a high standard of investigation work. The supervision of such work would be under the head of the Department concerned, and the thesis would have to be of a high standard similar to that required from resident students.

UNIVERSITY OF ALBERTA (Resolution of Faculty):—(1) That the suggestion of the C.S.T.A. that extra-mural graduate work in Agriculture be sanctioned presented no difficulty in principle to our Committee. It has been, in fact, in operation with us under certain conditions for a number of years.

(2) Our Committee was agreed also to approve the suggestion that extra-mural graduate work might be done for credit at this institution, under the supervision of a person whose professional competence was vouched for. It is understood that this supervisor should be nominated by the University Department concerned and that such nomination should receive the approval of the Committee on Graduate Studies.

UNIVERSITY OF BRITISH COLUMBIA:—The principle of Extra-mural Research has already been accepted and degrees granted on thesis work performed extra-murally.

EMPLOYMENT OF GRADUATE STUDENTS ON RESEARCH PROBLEMS

The question was asked of the Provincial Departments of Agriculture if any of their technical branches were in a position to employ graduate students on research, it being understood that they would be allowed to use the results of their work as thesis material but that their work, if required, would be on the regular research problems of the Department. Nova Scotia and Alberta replied in the affirmative, all other provinces replying in the negative.

TRANSFERENCE OF WORK, LEAVE OF ABSENCE, ETC.

The following questions were addressed to all Agricultural Colleges and Provincial Departments of Agriculture.

"(a) Are you willing to permit deserving junior members of your staff the privilege of transferring their work for a period not exceeding one academic year to some recognized institution of learning where it can be shown that such work can be performed there to better advantage? Each case would, of course, be decided by the Department on its merits."

"(b) In case of such a transfer, are you in favour of full time pay or otherwise?"

"(c) Are you in favour of allowing leave of absence for graduate work to those members of your staff who, in your opinion, are qualified for same?"

"(d) In case of such leave of absence, are you in favour of full time pay or otherwise?"

NOVA SCOTIA:—The Department endeavours to allow junior members of the staff leave of absence for graduate work, and if such members are engaged in working out some special problem, the Department would favour their transfer of work to institutions where better facilities are available for carrying on the work.

The Department would like in both of these cases to allow such men, as near as may be, full pay. At the same time it would not like to establish too exact a procedure in these cases, unless it were with the clear understanding that such arrangement would be put in force only in cases of well recognized merit.

NEW BRUNSWICK:—If we feel that any member of our staff will be more capable of handling the work they are engaged in by taking a short post-graduate course, we are quite willing to grant them leave of absence, and such pay, either full time or otherwise, as we consider the case will justify.

MCGILL UNIVERSITY:—There is no officially recognized plan in McGill University, under which members of the staff may obtain leave of absence. By individual arrangement, seven members of the staff of Macdonald College have been granted leave of absence and have obtained graduate degrees.

ONTARIO PROVINCIAL DEPARTMENT:—As regards the Department, apart from the College, there is no definite settled policy. Any case is dealt with on its individual merits.

ONTARIO AGRICULTURAL COLLEGE:—Our research work is chiefly limited to problems of a technical character that are thrust upon us, and that call for immediate investigation. Such work may be transferred to another agricultural college, or to the Experimental Farm at Ottawa, but not with any advantage to a University devoted to fundamental research.

If we can be convinced that such transfer could be made to advantage, so that certain assigned research work may be continued elsewhere, then we should be in favour of full time pay.

It has been our policy for the last five years to grant leave of absence for graduate work to members of this staff. In some instances leave has been granted with full pay. Whether full pay or part, has depended on the time of the year when absence is required, and the character of work in the Department, whether or not it can be carried on during the leave of absence by the remaining members of the staff in that Department. Where a substitute has been required the absentee has been required to pay the salary of the substitute.

FACULTY OF AGRICULTURE, UNIVERSITY OF MANITOBA:—We would not be prepared to lay down any general rule on this question of Transference of Work, but would consider specific cases on their merits.

It is the policy of this institution to give members of the Faculty leave of absence with pay for graduate study, whenever circumstances justify it.

SASKATCHEWAN:—No statement at this time.

ALBERTA (Provincial Department of Agriculture):—The Department does not feel that it would be justified in allowing a junior member of its staff to transfer his work for a period to some other institution, and at the same time receive either full time or part pay. This policy might be considered for some of the older members of the staff, but such a policy could hardly be adopted for those who had only spent a short time in the service.

The Department would have no objection to allowing leave of absence for graduate work to members of the staff who are qualified to undertake such work. The matter of pay for such leave of absence is one that would have to be decided by the government.

Such decision would be rendered on the merits of the case entirely.

Faculty of Agriculture, University of Alberta:—Leave of absence with full pay has been granted for summer courses, and in a few cases for longer periods.

British Columbia (Provincial Department of Agriculture):— The Civil Service Act, Chapter 35, Revised Statutes of British Columbia, 1924, precludes granting prolonged leave of absence (except in case of illness) with pay.

Faculty of Agriculture, University of British Columbia:—No definite policy as yet. Each case is decided on its merits.

Section B.

Dominion Department of Agriculture.

Mr. E. S. Archibald, Director of the Dominion Experimental Farms, as a member of the Committee, made an exhaustive enquiry throughout the Dominion Department of Agriculture as to the attitude of the various officials to various phases of the questions just referred to. Mr. Archibald's report is presented in abbreviated form.

A questionnaire, as drafted by Mr. Archibald, was forwarded to the chiefs of six other Branches of the Department of Agriculture, namely, Entomology, Seed, Fruit, Live Stock, Health of Animals, and Dairy. On the Experimental Farm, the same questionnaire was forwarded to eleven of the divisional officers, namely, Animal Husbandry, Field Husbandry, Cereal, Forage Crops, Horticulture, Chemistry, Botany, Poultry, Bacteriology, Tobacco, and Bees.

Question (1)—Are you in favour of Dr. Harrison's suggestion that graduate students should be employed on a part time basis, and is your department in a position to assist such students by temporary employment, presumably at nominal wages during the summer months, which, of course, under your supervision would count on his graduate work?

Of the fourteen answers received, thirteen answered decidedly in the affirmative. It is noteworthy that there already exists in the Seed Branch an arrangement whereby students in plant breeding work may be employed during certain periods in seed inspection work and paid at small salaries. It is also worthy of note that throughout all the Divisions of the Experimental Farms, undergraduate students are employed freely, the latter for more special work in which they are gaining experience in anticipation of further specialization and post-graduate work. Hence, the recognition of this work as a credit on post-graduate work would not in any way interfere with precedents already established as to the employment of such men.

Should such an arrangement ever be made with the universities, two things must be kept constantly in mind: (1) *The problems to be assigned to such men should be left largely to the Department.*. There should be no difficulty whatever in the university authorities and the Branch or Divisional Chief in question agreeing on this subject, treating each individual student on his own merits. Nevertheless, it must be clearly understood that the department is conducting research work and with distinct objectives in view. For this reason, the students working in the department must at least be devoting themselves to certain specific phases of the general scheme of research embodied in that department.

The students should be well recommended by the University authorities and should be men of sufficient training, ambition, and ability, so that they will not require a large amount of elementary supervision which would throw an absolutely unfair burden on the staff of the Department, which on the whole is already overburdened with detailed work.

Question (2)—Are you in favour of the recommendation of the Saskatoon Conference, namely, that for members of your staff desiring to continue their graduate studies, certain special phases of their work should count on the post-graduate degree?

With the exception of one Chief of a Branch of the Department, all the other Chiefs, and all the Divisional officers of the Experimental Farms Branch, answer this in the affirmative, and the more thoughtful reports in analyzing the question have agreed to it most heartily.

Question (3) a.—As to "transfer of work," it is recognized that in the Federal Department of Agriculture, under special circumstances, this has already been done, and the precedent established. Are you, in principle, in favour of such a transfer?

Where there are any divisions or Branches in which work could be transferred, all the

replies are in the affirmative. In other cases, they are in the affirmative in principle. There are no negative replies whatsoever, excepting the one Branch which feels it is scarcely interested in this whole problem.

b. In what Divisions of your work might you have men who might be so affected that their work might be transferred for a certain period to better advantage?

The Entomological Branch and the Cereal, Botanical, Field Husbandry, and Tobacco Divisions specify that in all of the subdivisions of their investigational work, they are in favour of such transfer of work. The Seed Branch specifies analytical research in seeds, fertilizers, etc. The Health of Animals Branch specifies Animal Pathology; Forage Crops specifies Breeding work. Horticulture specifies certain physiological and genetical problems in both pomology and vegetable work. Poultry specifies problems in genetics and nutrition. One divisional Chief and one branch Chief have distinctly specified no divisions of work susceptible to transfer of work at the present time.

c. In such a transfer are you in favour of full time pay or otherwise?

All replies were distinctly in favour of some allowance being granted as a stimulus to research workers. Some have given a great deal more thought to this question than others, and there are, as would be expected, several schemes proposed. Briefly, however, six replies in an unqualified way support the full time pay on post-graduate work; six support full time pay providing there is protection to the department which will give some guarantee of a man's returning to his position at the close of his post-graduate course. All these agree that there should be some fair period of time stipulated during which a man should stay in the employ of the department, and should he resign during that period, there should be some reimbursement to the department for the privilege and the sacrifice made by the department.

Perhaps all are aware of the present condition of affairs in the Federal Department of Agriculture in this matter, namely, that on special consideration men may be granted leave without pay, providing the department feels that the work may be taken care of, that the regular statutory holidays may be applied in addition thereto, and this year, for the first time, an order has been passed which allows the accumulation of statutory leave for two years only, previous statutory holidays applying only to that fiscal year.

On the whole, you will see, that there is a marked inclination on the part of all our chiefs of Branches and Divisions toward the stimulation of our present staff to take post-graduate work in order to still better equip themselves to conduct the work of the department. Also it is to be noted that there is a very healthy feeling of desire to co-operate with universities in order to assist any well-equipped promising men to obtain their credits on post-graduate work by granting them the privilege of working in the department on such special lines of work as the department is conducting, or anticipating carrying on. The healthy feeling of keen desire to co-operate with the educational institutions is most praiseworthy. This is quite natural for two reasons, namely, that the department is constantly looking for better equipped men to fill vacancies or new positions, and there is no way in which it can size up promising graduates as well as by some such scheme; and (2) it may allow the hiring at nominal or medium salaries, often on an hourly basis, of men distinctly above the average of men now available, in that such students will be keen workers, intensely interested, and well-equipped to take up some particular lines of work, satisfactory to themselves, as a basis for their post-graduate credits, and at the same time, work essential in the main lines of research conducted by the Department of Agriculture.

ASSISTANCE RENDERED BY U. S. DEPT. OF AGRICULTURE TO ITS EMPLOYEES

An outline of the assistance given by the U.S. Federal Department to its employees who wish to secure additional scientific training is of great interest. This statement was obtained by Professor Champlin from Mr. E. D. Ball, Director of Scientific work and of the Graduate School in the U.S. Department of Agriculture, and is submitted as Appendix B. of this report.

SUMMARY

The statements from the various institutions show that there is a great willingness on the part of all concerned to meet the needs of those graduates in the employ of the Dom-

inion and Provincial Departments of Agriculture who are desirous of taking post-graduate work. Possibly one is not too optimistic if the conclusion is presented that, if an employee of the Dominion or Provincial Departments of Agriculture wishes to proceed with post-graduate work, and has his research problem selected, and the research under way, not only will the Universities endeavour to meet his needs, but that the administrative heads of the Department or Division in which he is employed will do all that is possible to further his purpose.

ACKNOWLEDGMENT

In submitting this Report the Committee wishes to express its appreciation of the most cordial and prompt assistance rendered by all those to whom enquiries were addressed. To the members of the Committee who have made the necessary inquiries for their respective Provinces or Departments, and for the effective assistance they have rendered to this study of post-graduate work in Canada, the Chairman is under deep obligation.

Appendix A.

PROGRAMME, 1924-1925

I. An inquiry as to the attitude of University, Provincial and Dominion authorities on the following questions:

Extra-mural research,
Transference of work,
Leave of absence,
Salary arrangements.

II. A study of three fundamental questions:
   a. The relation between undergraduate and graduate courses with regard to division and sequence of work.
   b. The nature and content of courses leading to the master's and doctor's degrees.
   c. The general question as to what proportion of the graduate work might with advantage be taken in the natural science departments of our universities.

The foregoing to be based on a thorough study of the graduate courses now offered by the Class A universities of the United States, the universities of Great Britain, and present courses given in Canada, and to be accompanied by a statement as to the nature of the problems in agriculture now presented for interpretation, and the kind of training in research that will be required by those engaged in their solution.

III. A study of the collective resources of our Canadian universities from the standpoint of graduate work in agriculture.
   a. The graduate courses and research facilities available in the agricultural faculties of our Canadian universities.
   b. The possibility of utilizing to a greater extent the natural science departments of the different Canadian universities.

IV. If approved by the C.S.T.A., to place the recommendations of the Committee before the authorities of the Canadian Universities and the Dominion and Provincial Departments of Agriculture, and to endeavour to secure their adoption, and to promote co-operation in the carrying out of same.

CONCLUSION

The foregoing programme represents an endeavour to formulate a concrete plan of graduate work along the lines of the recommendations of the Universities Conference, a plan which will impose the least additional burden on the staff and administration of the Universities, and which will utilize to the fullest advantage all available facilities, and at the same time provide adequate opportunity for graduate work of the highest type.

Appendix B.

Statement prepared by Dr. E. D. Ball, Director of Scientific Work and of the Graduate School in the U. S. Department of Agriculture.

"Within the Federal Department a graduate school has been organized which offers courses on which credit toward a degree may

be obtained at the Universities. The courses are as follows:—

GENERAL COURSE.

1. Accounting Principles.
2. Elements of Statistical Methods.
3. Library Science.
4. Cataloging and Reference.
5. Glass Blowing Technique.

ADVANCED COURSES.

1. Credit, Currency and Prices with Special Reference to the Influence of Federal Reserve System.
2. The Principles of Animal Breeding.
3. The Principles of Animal Pathology.
4. Rural Sanitation.
5. Advanced Economic Entomology.
6. Plant Physiology.
7. Plant Cytology.
8. Plant Geography.
9. Botany in Relation to Plant Culture.
10. Bacteriology.
11. Theory of Analytical Chemistry.
12. Advanced Physical Chemistry.
13. Advanced Statistical Methods.
14. Physics of the Air.

These courses are *not* repeated except at infrequent intervals, so that each year the courses will be different from those of the previous year.

Each worker in the department is allowed to take one course and by special permission may be allowed to take two. The department does not plan to take the place of a graduate institution, but simply to give certain courses that will be helpful to the department workers in their immediate field of work, as well as be available for additional credits and to be offered in standard graduate institutions as partial requirements for advanced degrees. We had some 250 students in these different courses this past year. In addition to this there was something over 100 workers in the department who were enrolled in standard graduate institutions for advanced work. The department grants leave of absence *without salary* to take graduate work, or arranges to employ individuals on a part time basis so that they may take part time graduate work. Many of our department workers are located at experiment stations in connection with our larger universities. These workers are allowed to take up to a maximum of five hours credits per year of graduate work, while on full time government basis. If more than this is taken, then it is expected that there will be a part time arrangement. On the other hand, they often use the researches carried on in their government work for a thesis, and in that way are enabled to take a much larger number of credits. In a number of cases where it was felt especially desirable to have an individual take advanced training in a particular line, his research work has been transferred to the laboratories of some standard university, thus enabling him to take part-time graduate work at the same time he takes on his research. The department exercises of course a high degree of selection in choosing and especially encouraging the men to take this work. No one is encouraged who is not considered to be capable of development, and, in general, outstanding men are the ones who are given the encouragement along these lines.

We have already found that this system has made a tremendous difference in the morale of the working force. It is now much easier for us to obtain outstanding young men than it was formerly, and there is developing a much stronger spirit of research than formerly existed. We feel sure that this System has been highly beneficial and at the same time there has been no expenditure except a little time of the committee in supervision of the work. The tuition of the students has covered all the expenses, and the work is done after closing time, so that it has not interfered with the regular work of the individuals."

Report of the Committee on Research.

W. P. THOMPSON, Chairman

University of Saskatchewan, Saskatoon

Introductory Remarks.

For some years the chief work of the Committee on Research has been the compilation of a list of agricultural research problems under investigation or projected in the various Canadian institutions. As a result of that work a list was published in *Scientific Agriculture*, September, 1922. That list had certain shortcomings: (1) It was incomplete. (2) It did not distinguish between problems actually under investigation and those which it was considered desirable to investigate. (3) It gave no information as to where or by whom different problems were being studied. Since that time the committee has endeavored to supply those deficiencies, and during the past year an effort has been made to whip the list into final shape. The result is appended hereto.

The writer is fully aware that the list still has many shortcomings. Each member of the committee (which was chosen so as to be representative) was given a copy of the list as it came from last year's committee and asked to amend and amplify it in consultation with his colleagues. Replies have been received from only six of the eleven members of the committee, and several of those from whom replies have been obtained report considerable indifference and failure to report on the part of particular departments. For an entirely different reason, a glaring omission is the work of the Dominion Experimental Farms System. But the System is preparing a list of its own which is now nearly ready for publication and may be used as a companion to the present list.

On the other hand the list is, I believe, in some respects too complete! One has only to divide the number of problems listed by the known number of investigators in Canada to determine that either many problems are not being seriously studied or are of little consequence. Somebody is spreading himself very thin. For obvious reasons the committee cannot attempt to remove padding. It may be desirable to have important problems listed even if they are not being seriously studied. But in my opinion a number of the titles should not be dignified by a place on a list of researches. Naturally, however, no one cares to undertake the deletion of a colleague's pets.

It will also be noted that many of the problems are listed as not being studied by anyone. Their inclusion is due to the following facts: (1) The original committee asked for suggestions both as to problems actually being studied and those in need of study; to eliminate the latter would disarrange the classification and numbering which, it was thought, should be left as nearly as possible the same as in the former published list. (2) A number of the staff of the Experimental Farms furnished lists to the original committee and since they are publishing a list of their own, the Farms and their personnel have not been included in the present list.

In view of what has been said the question arises as to the desirability of publishing the list in the present form. On this question the convention must reach a decision. The writer has made an earnest effort to secure the opinions of the other members of the committee. Only three have given statements for themselves and their colleagues. These three happen to be connected with the Agricultural Institutions which are probably best known in Canada. One favors publication one is opposed, and one neutral. Quotations from the reports may make the state of opinion clearer. One says, "I find a marked difference of opinion here as to the value of the list for publication and considerable indifference to the whole project". The second says, "As the list stands there seems to be very little to say against it. Most of the men agree that it furnishes very useful information and in a form that is quite concise but still full enough to serve its purpose". The third writes "I think I may say that your view that the list of projects prepared by last year's committee is unsatisfactory and that little good would result from its publication without revision is pretty generally shared". I am personally still in agreement with the view just expressed though I must say that

nearly all my colleagues in Saskatchewan favor publication.

A number of men express the opinion that the list should be published after extensive revision and elimination of the titles which are not being actively studied and of those which involve little or no real research. On the other hand there is something to be said in favor of having the list include problems which need study but are being neglected. And it would be very difficult to secure a committee which would undertake to discriminate between problems reported as being investigated. If that is to be done next year's committee should be chosen, not with reference to geographical considerations, but purely to secure experts in each subject to revise the list.

The convention should then decide the following questions:

(1) Should the list be published or not?

(2) In case the answer to the above question is in the affirmative, should the list be published as it now stands or after extensive revision and elimination of titles?

It is to be understood that unless there is definite indication to the contrary, the opinions expressed in the preceding paragraphs are those of the Chairman only and not of the Committee as a whole.

NOTE: The list which was embodied in this report is now before the new committee, which was appointed chiefly for the purpose of editing the list before publication. Revision will of necessity be slow and it is hoped that further lists may yet be secured before the final report is published.—Ed.

BOOK REVIEWS.

MANUAL OF VEGETABLE GARDEN DISEASES, by Chas. Chupp. XXIV + 647 pp., 155 illus. Rural Science Series. Macmillan.

The Rural Science Series under the editorship of Dr. L. H. Bailey has added its sixteenth volume to a set of valuable manuals, which are designed to popularize scientific information in certain fields pertaining to rural life for workers in those fields. Incidentally they are valuable to the technical worker inasmuch as they constitute compendia of salient facts.

The book on diseases of the vegetable garden by Dr. Chupp of Cornell University is the latest of the series. It deals with vegetable diseases on a crop basis and includes some twenty-nine crops. Most attention is paid to those of major economic importance e.g., Bean diseases pp. 12-64, potato pp. 348-464, cucurbit pp. 179-229, tomato pp. 531-599, etc.

The book is profusely, and on the whole, well-illustrated.

Each disease is treated succinctly and with detail justified by its economic status, while at the close of each account citations of most recent work appear. Special attention has been given to symptoms and control and too great technicality avoided. A chapter (XIX) on soil sterilization and one (XX) on Fungicides complete the book.

There are three technical points which come to the reviewer's attention. On p. 394 the statement is made concerning Black-wart of potatoes—"The disease is now prevalent in parts of Hungary, Germany, Holland, Scandinavia, Italy, Great Britain, South Africa, Canada and the United States". It should be noted that this disease does not occur in Canada. It does occur in Newfoundland. Neither does it occur in Italy as the reviewer found out in 1923 (*vide* Dr. Giulio Trinchieri, "Su la pretesa presenza, in Italia, della 'rogna nera' della potata". Revista di Biologia, 5: 139-140, 1923).

The third point is that, following Taubenhaus, the Phellomyces stage of *Spondylocladium atrovirens* is regarded as a sclerotial stage of *Colletotrichum atramentarium*. This is not the case; the two organisms are separate as to sclerotia.

The last two points are included in this review, not as a criticism of Dr. Chupp's survey and summary of literature (which must have been a tremendous task) because the facts were not available to him, but in order that they may be duly noted.

Finally the text is easy to read both as to print and verbiage and the book will undoubtedly be in considerable and justifiable demand.

B.T.D.

Organization of Prairie Provinces Society of Animal Husbandry.

Some seven years ago the men in the Prairie Provinces working on Field Husbandry problems organized the Western Canada Society of Agronomy. This organization has since held annual meetings and has accomplished very necessary and useful results in bringing together the men engaged in field husbandry, enabling them to discuss, understand and appreciate the work which each man or institution is carrying on, and to co-operate this work to the mutual advantage of all concerned.

Many of the men who annually attend the meetings of the Western Canada Society of Agronomy are either in charge of work in one or more branches of animal husbandry or directly engaged in some branch of animal husbandry experimental work. The necessity for co-operation in and standardization of work in animal husbandry has long been realized and an idea in the minds of many men was crystallized when the Director of the Dominion Experimental Farms, Mr. E. S. Archibald, made the suggestion that with very little additional expenditure of time and money a meeting of animal husbandry men could be held at the same time as the field husbandry men hold their annual meeting. Mr. Archibald in his letter suggesting the organization of an animal husbandry association also concisely outlined as follows much work which requires immediate attention:

1. "Review all past animal husbandry experimental work which has been conducted in the three prairie provinces.
2. Classify all present experimental work stating where each line of work is being conducted and the volume of such work at each station.
3. Review the present animal husbandry problems in the light of present experiments.
4. Discuss the major present problems in the light of future experiments which should be undertaken and discuss how such lines of work might best be apportioned.
5. Undertake the standardization of:
   (a) Animal husbandry terms.
   (b) Feeds for animal husbandry experiments.
   (c) Experimental methods.
   (d) Interpretation of experimental results.
6. Consider ways and means whereby in the annual convention or by committee previous thereto, experimental work from all stations might be collated so that all members might have the benefit of the complete analysis of most recent results."

At the annual conference of the Superintendents and Assistant Superintendents of the prairie province Dominion Experimental Stations held at Lacombe an address on "Standardization of Experimental Work in Animal Husbandry" was given by Professor Sackville of the University of Alberta. Professor Sackville more fully outlined the valuable work which should be done by an association of animal husbandrymen, and following this address a temporary committee was appointed to arrange for the first meeting of this organization in Saskatoon immediately following the meeting of the Western Canada Society of Agronomy in December, 1925. This committee is: Professor Sackville, Chairman; F. H. Reed, Secretary; W. H. Gibson, representing Saskatchewan and M. J. Tinline, representing Manitoba. It is proposed that the membership should include members of the staffs of the Dominion Experimental Stations, members of the staffs of the Agricultural Departments of the three Provincial Universities, men in charge of other government or privately owned institutions or farms where experimental work with live stock is being carried on, and the Live Stock Commissioners of the Prairie Provinces.

At the annual convention of the C.S.T.A. in Edmonton this new organization was explained to the society by Professor Sackville and on the motion of H. A. Craig and W. B. Roadhouse it was decided that the Prairie Provinces Society of Animal Husbandry would be given all possible co-operation and support by the C.S.T.A.

F. H. R.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

A la Convention d'Edmonton.*

LOUIS-PHILIPPE ROY

Il me serait pénible de répondre à l'invitation de notre secrétaire français Mons. H.-M. Nagant, pour écrire un compte-rendu de la réunion annuelle de la C.S.T.A., si, après plusieurs jours de long trajet et de travail plutôt laborieux, je ne pouvais compter sur l'indulgence de mes amis-lecteurs.

Disons tout d'abord, qu'il faisait bon, après trente-six heures d'une course effrenée à travers la prairie aux horizons sans fins, d'arriver dans la coquette ville d'Edmonton, où l'altitude et la latitude vous protègent d'une chaleur parfois redoutable, dans ce pays du blé.

L'université—où avait lieu la convention —est située entre les champs cultivés et les murs de la ville-capitale, au sommet des verdoyantes collines qui surplombent la fougueuse rivière Saskatchouanne. Ici, tout est repos et tranquilité; ce sera dorénavant, notre lieu de retraite pour une pleine semaine. Cette université, vieille de quelques années à peine, groupe déjà, sur un même "campus", plusieurs facultés très bien outillées et dont la faculté agricole n'est certes pas la moins imposante.

Je ne sourais entrer dans plus de détails sur la convention, sans payer un juste tribut de gratitude au doyen de la faculté d'agriculture, Mons. E.-A. Howes, notre président général. C'est à lui, de même qu'à notre si sympathique secrétaire Grindley, que revient le principal mérite du succès de la convention . Le doyen Howes, sans faire beaucoup de bruit, est un fameux appoint pour la C.S.T.A.. Il ne s'impose jamais mais voit à ce que tout marche selon l'esprit le plus courtois. L'hospitalité qu'il nous offrit, de même que ses égards pour le seul représentant canadien-francais, feront, je l'espère, l'objet d'un bout de causerie agréable lorsque je serai de retour à Québec.

Ceux qui y étaient.

L'assistance, tout en n'étant pas des plus nombreuse, offrait une bonne représentation des provinces de l'ouest et du centre. Si l'on tient compte de l'éloignement de l'endroit choisi et de la population plutôt éparse des provinces de l'ouest, nous avions lieu d'être pleinement satisfaits. Les provinces étaient représentées comme suit: Alberta 47; Colombie 6; Manitoba 9; Ontario 15; Québec 5; Sask. 11.

La convention, dans son ensemble, fut un succès tel que, plusieurs de nos amis sont portés à croire que c'est la mieux réussie à date. Plusieurs éminents producteurs de semence ont été admis à nos séances et quelques-uns des plus réputés ont été admis comme membres (dont le major H. G. L. Strange, le fameux exposant de blé à Chicago).

Conférences.

Grace à la bienveillante coopération du ministère fédéral, il nous a été possible d'entendre des agronomes très distingués, tant des Etats-Unis que du Canada, nous traiter, de main de maître, les sujets les plus variés et les plus nouveaux en matière d'agronomie. Citons les suivants:

M.M.—J. M. Evvard Ames, E. U.; D. R. Hoagland, Califournie, E. U.; R. Newton, Alta., Can.; E. H. Strickland, Alta., Can.; F. W. Wyatt, Alta., Can.; V. W. Jackson, Man., Can.

* Ce compte-rendu fut écrit très hâtivement et imprimé sans corrections.

Il me fut impossible de suivre et de pouvoir apprécier toutes ces "lectures" mais je crois que nous pouvons espérer en lire de substantiels extraits dans notre revue.

Des comités élus l'an dernier et qui devaient faire rapport à cette convention, nous ne citerons que les deux principaux, lesquels nous communiquèrent des travaux très complets et d'une haute valeur: le comité sur les "graduate studies"—traduise qui peut—et le comité sur "Educational policies". Ce dernier, présidé par notre ex-président M. Klinck, était d'une étoffe peu ordinaire et M. Klinck, en soutenant le débat, se revela, comme toujours, l'homme à l'esprit synthétique et lucide que nous connaissons depuis le début. Ce rapport sera publié *in-extenso* dans la revue agronomique. Souhaitons que les Gagné, Toupin, Létourneau, Fontaine, Nagant, etc., s'y interesseront de près. Ici, nous nous permetterons de déplorer que, par un jeu de circonstances aussi incontrolables que fâcheuses, nos gens de Québec, faisant partie de ces comités, n'aient pu donner la mesure de leur connaissances. Y serons-nous l'an prochain?

Souscriptions.

Le nombre de nos membres augmente graduellement. Plusieurs sections désiraient voir la souscription annuelle descendre à $5.00 mais, ce projet qui pouvait mettre en péril notre société, a été rejeté.

Une nouvelle clause de la constitution pourvoit à l'acceptation, comme membres, des élèves finissants des collèges agricoles, moyennant une contribution annuelle de $3.00. Au surplus, et en vue de hâter l'entrée, dans notre société, des nouveaux gradués pour lesquels la souscription initiale de $10.00 était trop élevée, il a été décidé de mener, d'ici au 1er janvier, 1926, une active campagne de recrutement et d'accepter, jusqu'à cette date, les gradués non-membres, moyennant la contribution annuelle de $6.00 seulement. Cette mesure, assure-t-on, permettera de diviser les gradués en deux catégories: ceux qui veulent être membres de la C.S.T.A. et ceux qui ne veulent pas le devenir. "Plus de lumière....."

La convention a adopté une résolution pourvoyant à la création d'un bureau d'emploi au secrétariat même de la société. M. Grindley nous parlera bientôt de son projet.

La convention s'est terminée par un joyeux et intéressant voyage sur le ranch du Prince de Galles, au pied des Rocheuses, à quelques soixante milles au sud-ouest de Calgary. Il serait superflu de dire jusqu'à quel point il nous fut agréable d'etre reçu d'une manière aussi royale—c'est le cas de le dire—par le très ingénieux et l'excellent éleveur qu'est M. Carlyle, le gérant du ranch royal. Nous avons pu admirer là, à peu près 500 têtes des plus beaux spécimens zootechniques apportenants aux espèces chevaline, bovine et ovine. Que de beaux "thoroughbreds"!

Un lunch à faire frémir les muqueuses les plus rétiscentes, nous fut gracieusements servi dans l'oasis du ranch qui est traversée par un vigilent ruisseau d'argent, sueur des rocheuses.

Qu'il me suffise de dire que votre représentant canadien-français à reçu beaucoup plus que sa part de courtoisie et d'aimables attentions de toutes sortes, de la part de nos amis les "Westerners". Encore un fois, je leur dis "thank you".

NOUVELLES DE NOS ECOLES D'AGRICULTURE

Nouveaux Bacheliers en Science agricole.

Le 17 juin, date qui marquait la fin de l'année académique 1924-1925 à l'Institut Agricole d'Oka, eut lieu la proclamation de six nouveaux bacheliers en science agricole. Voici la liste de ces messieurs établie d'après le pourcentage de points conservés pendant les quatre années de cours pour l'obtention du diplôme: M. Robert Raynaud, 77.3; M. Damase Limoges, 75.7; M. Irénée Gervais, 73.7; M. Hector Tessier, 72.7; M. Gustave Charbonneau, 66.6; M. Georges-L. Giasson, 61.7.

Nous adressons nos bien cordiales félicitations à ces nouveaux confrères et tous nos voeux de succès les accompagnent dans la carrière agronomique.

NOUVELLES DE NOS MEMBRES.

Nous apprenons que M. Adrien Desautels, B.S.A., attaché au Service d'Horticulture du département de l'Agriculture à Québec, a conquis sa Licence en Philosophie à l'Université Laval de Quebéc avec la mention distinction. Nous présentons nos meilleures félicitations à monsieur Desautels.

Problèmes actuels en matière d'engrais phosphatés.

H. M. NAGANT

Professeur à l'Institut Agricole d'Oka

Variétés de scories

Depuis quelques années, il règne assez de confusion, dans les milieux agricoles, sur la manière de juger la valeur des engrais phosphatés, plus particulièrement des différentes variétés de scories de déphosphoration, sous produits de l'affinage des fontes phosphoreuses par divers procédés. Disons aussi, tout de suite, que ces facteurs d'incertitude ne se manifestent pas seulement dans les milieux de cultivateurs pratiques peu au courant des questions théoriques en matière d'engrais chimiques, mais encore parmi les agronomes supposés être au fait de toutes les données que possède la science pour expliquer le comportement des fertilisants vis à vis du sol et des cultures auxquelles on les applique.

Remarquons d'abord qu'il y a, depuis une dizaine d'années, trois variétés de scories de déphosphoration auxquelles on continue parfois à appliquer la dénomination de "Phosphate Thomas", quoique improprement pour deux d'entre elles:

1.—*Le phosphate Thomas proprement dit*, obtenu dans le convertisseur Bessemer, par le procédé basique connu sous le nom de l'un des deux inventeurs qui s'appelaient Thomas et Gilchrist.

2.—*Les scories de déphosphoration "Open heart" ordinaires*, sous produits de l'affinage dans le four ouvert, dénommé aussi four Siemens Martin.

3.—*Les scories de déphosphoration "Open heart" au "spath fluor"*, provenant du même four Siemens Martin, mais avec revêtement intérieur de fluorure de calcium ($CaFl_2$), employé, actuellement, beaucoup en Angleterre au lieu du revêtement calcaire ou dolomitique.

Ceci sans tenir compte de différents types de ce que l'on pourrait qualifier de thermophosphates ou scories artificielles, obtenues par la scorification de mélanges de phosphates minéraux de matériaux calcaires, de carbonate de soude et autres substances, chauffés à haute température dans des fours spéciaux.

Parmi ces thermophosphates il y aurait lieu de mentionner par exemple: le phosphate Peerles, le phosphate Rhenania, le phosphate Supra (Bernard), le tétraphosphate du Dr. Stoppani (en Italie), tous actuellement sur le marché.

On se rappelle aussi le principe du procédé de Thomas et Gilchrist, lequel consiste à remplacer la doublure siliceuse de la cornue Bessemer par un revêtement de calcaire magnésien ou de dolomie et à ajouter une certaine proportion de chaux, à la fonte avant l'affinage.

Le silicium et le phosphore qui se trouvent en dissolution dans le métal sont oxydés à l'état de $Si\ O_2$ et P_2O_5; se combinent avec les radicaux basiques, représentés principalement par CaO, pour former des silicates, phosphates et silicophosphates de chaux, d'une structure moléculaire compleze et assez mal définie, qui viennent surnager à l'état de laitier au-dessus du bain de métal affiné. Cette scorie, après solidification, est finement pulvérisée et constitue le phosphate Thomas proprement dit.

Forme de l'acide phosphorique dans le phosphate Thomas.

Depuis ses applications en agriculture, a partir de l'année 1885, de nombreuses recherches furent effectuées par des savants de divers pays pour établir la forme exacte qu'affecte l'acide phosphorique dans le phosphate Thomas. Les résultats sont restés peu concordants. Ainsi, on admit d'abord que le P_2O_5 se trouverait surtout à l'état de phosphat tétracalcique $Ca_4P_2O_9$ dont les cristaux furent trouvés, par Hilgenstock, dans des géodes de scories, ensuite on pensa qu'il affectait la forme de silicophosphate de la formule $Ca_3(P\,O_4)_2\ Ca\ O.Ca\ Si\ O_3$.

Ce qu'il y a de plus vraisemblable c'est que la composition n'en est pas uniforme et varie avec les températures atteintes au cours de l'opération d'affinage, les proportions de $Si\ O_2$ et autres éléments entrant dans la constitution de la scorie.

Une telle hypothèse est d'ailleurs confirmée par les variations de solubilité, dans

différents réactifs, et d'assimilabilité pour les plantes, constatées chez les scories de déphosphoration.

Le procédé Wagner.

C'est alors que Wagner, directeur de la station agronomique de Darmstadt, en Allemagne, entreprit ses fameuses expériences en pots pour se rendre compte de la valeur fertilisante du phosphate Thomas. Au cours de ces essais, il remarqua une coïncidence assez nette entre le degré d'assimilabilité de l'acide phosphorique et sa solubilité dans l'eau additionnée de 2% d'acide citrique. De là naquit la méthode conventionnelle, adoptée presque universellement par tous les laboratoires, d'exprimer l'assimilabilité relative du P_2O_5, des scories de déphosphoration, en fonction de la quantité pour cent d'un échantillon de poids déterminé passant en dissolution dans un volume également déterminé d'acide citrique à 2%, après agitation du mélange durant trente minutes à une température fixée.

Apparition des scories "open heart."

On peut dire que tout alla assez bien et que la méthode Wagner ne donna pas lieu à grandes discussions jusqu'à ce que la substitution graduelle du procédé "Open heart" à celui du convertisseur Thomas, commencée il y a dix ans, en Angleterre, en raison d'une différence du prix de revient à l'avantage du premier, opéra une révolution dans la production de ce déchet de la grande métallurgie, si recherché par l'agriculture.

Sans aborder la description du four dit "*open heart*", ou Siemens Martin, dont le nom indique déjà une différence essentielle avec la cornue Thomas, il souffira de faire remarquer qu'il comporte lui-même deux variantes, suivant que la doublure interne est analogue à celle du convertisseur, ou constituée de fluorine $CaFl_2$, minéral appelé "spath fluor".

Il y a donc à faire la distinction aussi entre deux espèces de scories de déphosphoration "open heart": les ordinaires et les scories fluorurées, de constitution beaucoup moins uniforme que celle des scories Thomas, tant en ce qui concerne leur richesse en acide phosphorique total que le degré de solubilité de celui-ci dans le réactif Wagner et son assimilabilité pour les plantes.

La demande pour les phosphates basiques allant en augmentant, depuis la fin de la guerre, et la production du phosphate Thomas diminuant toujours, pour la raison exposée plus haut, les cultivateurs du Royaume-Uni furent bien obligés d'avoir recours aux scories "open heart", et cela malgré leur richesse souvent médiocre et certains résultats décevants par rapport à l'assimilabilité.

Comité pour l'étude des scories de déphosphoration.

En présence de ces conditions, un comité fut institué, sous les auspices du ministère de l'agriculture du Royaume-Uni, en vue d'étudier toute la question et de chercher notamment des moyens d'augmenter l'efficacité des scories de qualité inférieure obtenues par les méthodes nouvelles ou de leur trouver un substitut effectif dans les phosphates minéraux.

Un grand nombre d'essais culturaux furent exécutés depuis l'année 1917, dans différentes parties des iles britanniques. C'est ainsi que des expériences sont poursuivies à Rothamsted avec des phosphates de l'Afrique du Nord et que le comité reprend, en outre de ses propres essais, toutes les expériences culturales sur phosphates naturels et scories qui sont poursuivies dans les différentes régions du pays sous l'égide de "l'Agricultural Education Association".

Ils démontrèrent que s'il y a de grandes variations dans le degré d'assimilabilité des différentes espèces de scories de déphosphoration, il en existe aussi de très étendues pour les phosphates naturels, suivant leur origine et que, de plus, ces variations sont encore fortement influencées par les conditions climatériques (précipitations atmosphériques) et la nature des sols auxquels on applique les engrais.

Résultats acquis.

Depuis lors, plusieurs rapports très documentés ont paru, notamment au cours des années 1922 et 1923, dans des revues agricoles ou scientifiques anglaises, tels que "*The Journal of the ministry of agriculture*" et le "*Journal of the Society of chemical industry*", de Londres.

Ces rapports eux-mêmes sont analysés dans les numéros de mars, avril, et mai et juin 1923 des "*Annales de la science agronomique française et étrangère*", ainsi que dans "*La Revue de renseignements agricoles*", de l'Institut International de Rome auxquelles nous empruntons quelques conclusions résumées.

Scories "open heart" ordinaires.

D'après le "*Second interim report of the permanent committe*" (*Journal of the ministry of Agriculture* p. 524–530, année 1922) es scories "open heart" ordinaires, à haute solubilité citrique, ont la même valeur agricole que les anciennes scories Thomas.

Celles à faible solubilité se sont montrées nférieures, mais, dans certaines circonstances, la différence ne serait pas grande. Il y a cependant des variations très sensibles dans 'efficacité, et il y a des raisons de supposer que ce genre de scories renferme des produits de nature très différente, bien que la solubilité citrique ne permette pas de les caractériser.

Scories "open heart" au spath fluor.

Compte-rendu d'expériences faites entre les années 1917-1921 sur des prairies du comté l'Essex, dans des sols pauvres en acide phosphorique, et sur des terres arables dans le nord de l'Irlande.

Dans ces essais, où différentes formes d'engrais phosphatés furent appliqués à raison de 200 lbs. de P_2O_5 par acre, en une seule fois, et pour toute la durée des expériences, les scories au spath fluor ne se sont pas montrées aussi efficaces que celles à haute solubilité. Elles ne sont cependant pas aussi mauvaises que le chiffre de solubilité pourrait le faire présumer. Leur infériorité est surtout marqués lorsque le sol n'est pas acide et que les précipitations atmosphériques sont faibles; mais, quand le sol est acide et que la quantité de pluie est forte, leur valeur pourrait se rapprocher beaucoup de celle des types les plus solubles. On estime que dans la fumure des prairies les scories au spath fluor peuvent avoir une valeur de de 50 à 70% de celle des scories à haute solubilité citrique.

O. N. MacArthur, sous le titre: "*The constitution and manurial value of low grade basic slag*" paru dans "*Journal of the Society of chemical industry,* p. 213-216, Londres 1923", rend compte d'un grand nombre d'analyses microscopiques et chimiques qu'il a effectuées sur des scories "open heart", lesquelles furent également essayées dans de nombreuses expériences en pots et en plein champ. Il en conclut que les scories au spath fluor ont certainement une valeur fertilisante et préconise leur utilisation à la place des calcaires moulus employés comme amendement du sol. Cependant leur valeur fertilisante ne serait pas comparable à celle des scories Thomas.

Phosphates naturels.

Voici maintenant les conclusions générales émises relativement aux phosphates minéraux de diverse provenance (tels que les pebbles de Floride, coprolithes de Cambridge, phosphates minéraux d'Algérie, de Tunisie et d'Egypte) qui furent essayés, concurremment avec les scories de déphosphoration, au cours des expériences mentionnées. Toutes les expériences semblent démontrer que les phosphates minéraux, en général, ont une valeur fertilisante beaucoup plus élevée qu'on ne l'a admis jusqu'ici.

Déjà dans les conditions favorables surtout aux scories à haute solubilité citrique, telles que faible hauteur de précipitations atmosphériques et absence d'acidité du sol, la valeur des phosphates minéraux appliqués aux prairies a été très voisine de celle des premières. Dans les sols acides et où la hauteur de pluie reçue est considérable, certains faits tenderaient même à démontrer que les phosphates minéraux peuvent être parfois supérieurs aux meilleures scories basiques.

Enfin, dans tous les essais, ils se sont montrès plus efficaces que les scories "open heart" au spath fluor.

D'autre part, des comparasions établies entre les phosphates naturels, suivant la provenance, il résulte que les phosphates de l'Afrique du nord, plus solubles, sont supérieurs à ceux de la Floride, quoique moins riches en P_2O_5, les seconds étant plus durs et plus insolubles.

De tous les phosphates minéraux, c'est celui de Gafsa (Tunisie) qui s'est montré le plus approprié à l'emploi direct.

Critique de la méthode Wagner.

Les résultats généraux des expériences dont il a été question, joints au désir de tirer parti des scories de déphosphoration obtenues par les méthodes nouvelles d'affinage de la fonte, ont suscité de nombreuses critiques contre la méthode Wagner pour la détermination de l'assimilabilité relative du P_2O_5 des engrais phosphatés.

Si l'on continue à admettre, il est vrai, que les rendements culturaux diminuent avec la solubilité du P_2O_5 dans une solution d'acide citrique à 2%, il serait cependant établi que cette diminution de récolte n'est pas parallèle à celle de la solubilité. En d'autres termes l'épreuve officielle à l'acide citrique exagérerait l'infériorité des scories faiblement solubles.

De là, des recherches entreprises pour modifier la méthode Wagner de façon à établir une meilleure concordance entre le taux de solubilité dans le laboratoire et celui de l'assimilabilité dans le sol.

C'est ainsi que dans un mémoire présenté à la Société Faraday *"the valuation of insoluble phosphate by means of a modified citric acid test"* (*Journal of the Society of chemical industry* p. 59-66, *année* 1923) G. S. Robertson a fait remarquer que lorsqu'on modifie la méthode Wagner en usage, de manière à ne soumettre qu'un échantillon d'*un* gramme du phosphate au lieu de 5 grammes, à l'action dissolvante d'une même quantité de réactif, et cela dans des conditions identiques pour le reste, on obtient une nouvelle échelle de valeurs pour le phosphate contrastant souvent d'une manière frappante avec les résultats obtenus par la méthode officielle.

D'autre part, les nouvelles valeurs trouvées concorderaient beaucoup mieux avec les résultats culturaux obtenus sur les parcelles d'expériences que celles indiquées par la méthode Wagner officielle.

Si la méthode à l'acide citrique, modifiée, établit des différences parmi les scories du groupe "open heart" au spath fluor, selon les auteurs, ces différences se manifestent plus nettement encore entre les phosphates naturels de diverses origines.

Cependant, ils déclarent que même après cette modification, la méthode ne présente pas de fondement scientifique; elle ne représente qu'une amélioration d'un procédé empirique, mais utile quand même dans l'appréciation approximative et rapide de la valeur relative des engrais phosphatés.

La solution véritable du problème ne pourra être obtenue qu'à l'aide de nombreux essais culturaux faits dans des conditions variées de sols et de climat, disent-ils. Après cela il sera permis de fixer les conditions et de dresser les cartes des régions agricoles dans lesquelles l'emploi des phosphates insolubles pourra être pratiqué avec autant d'avantage que celui des scories solubles.

Conclusion finale.

Si l'intérêt du problème des scories de déphosphoration auquel est venue par surcroît s'ajouter, sous une forme ravivée, la question déjà vieille des phosphates minéraux, a son centre dans les îles britanniques, il s'étend cependant aussi dans une large mesure au Canada et surtout à la province de Québec où les phosphates Thomas ont figuré, de longue date déjà, parmi les fertilisants les mieux connus et les plus appréciés.

Aussi, des discussions considérables ont surgi à leur endroit à la suite de mise en vente de scories des nouveaux types, importées d'Angleterre ou fabriquées en Nouvelle Ecosse. C'est ainsi que la loi fédérale sur le commerce des engrais a eu des hésitations relativement aux exigences du contrôle d'assimilabilité à imposer aux scories basiques. Après avoir supprimé l'obligation de la garantie de solubilité citrique suivant la méthode Wagner, qui figurait dans la loi de 1909, elle semble vouloir y revenir ou du moins à une méthode modifiée.

Quant à nous, une chose, nous semble-t-il, reste acquise: c'est que si les scories à faible solubilité citrique sont, dans certaines conditions, équivalentes ou à peu près aux anciennes scories Thomas fortement solubles, on est cependant beaucoup plus assuré de l'efficacité de ces dernières dans toutes les conditions.

Alors l'épreuve par la méthode Wagner, primitive ou modifiée, reste cependant une très bonne garantie pour le cultivateur, d'autant plus qu'elle empêchera toujours l'adultération des scories basiques au moyen de phosphates minéraux peu actifs, tels que ceux de Floride. Et il sera bien naturel que l'on continue à donner la préférence, ici, au phosphate Thomas proprement dit, importé des pays continentaux de l'Europe, dont on peut garantir un haut pourcentage de solubilité citrique.

Feeding the World.*

SIR A. DANIEL HALL

Scientific Adviser to the British Ministry of Agriculture

I

At the present moment the position of agriculture in both America and Great Britain presents certain contradictory yet significant conditions which demand the most earnest consideration. That the situation of the farmers themselves is uneasy is indicated by the commissions of inquiry that have been set on foot in each country in the hope of discovering legislative action for the benefit of agriculture, and by the statistics of abandoned farms in the United States and of the shrinking area under the plough in Great Britain. The farmer is not finding his business worth while. On the other hand, the public is restive under the rising prices of food, prices which seem disproportionate to the share which gets back to the producer. Yet no one has discovered a method of clipping the toll taken by the dealer and the retailer; and though co-operative marketing is being pressed upon the farmers, and in some cases successfully pursued by them, it is doubtful whether the marginal saving it can effect will fundamentally remove the difficulties of the producer.

In despair the American farmer is being counseled to reduce his output to the amount that will satisfy the home market—a procedure difficult enough in any case, with the fluctuating yields due to season, but impracticable for farmers who are not united in an association that can enforce instructions upon its members. An individual can rarely see safety in limiting his output—his natural tendency is to get ahead of the average; if, however, he works to cheapen his output, that effort will on the whole be attended by smaller gross yields. Lessened production follows in unconscious response to the pressure of low prices; farmers cheapen and lower their standard of cultivation, abandon the marginal land, or turn it down to grass as in Great Britain. The continent of Europe presents a not dissimilar situation; though tariff walls safeguard the position of the farmers, they are not producing enough food for the needs of the community, and complaints of the high cost of living are universal. Despite poverty and adverse exchanges, European countries are being forced to import foodstuffs; in few cases do the statistics show increasing agricultural production.

In face of these universal complaints of high and rising food-prices, can it be supposed that a general policy of reduced production will solve the difficulties?

Long before the resulting scarcity enables the farmer to satisfy his requirements, the dealers handling commodities that are indispensable, yet in short supply, will have forced up prices to intolerable limits; they, rather than the farmers, would hold the community to ransom, and wartime experience shows pretty clearly the impossibility of disciplining traders without an adverse reaction upon production.

We have to face the fact that food is in the process of becoming scarce in relation to the increasing population of the world. In his *Mankind at the Crossroads* Professor East has just published a striking exposition of the path the world is following. Populations are continuing to rise and, except in France, at an increasing rate; even the World War has caused no more than a flicker in the ascending curve. Yet where during the present century can be seen the corresponding expansion in food-production? With the exception of the growth of the cultivated area in Canada, there has been nothing since 1900 to compare with the opening-up of the Middle West, of Argentina, and of Australia during the previous half-century. That was the great period of growth of agricultural supplies, of cheapening food, and we have got into the way of regarding the sources as illimitable and the process as continuous. But new lands are no longer available.

Russia used to be a considerable exporter of wheat and is expected eventually to resume

* Reprinted from the May, 1925, issue of the *Atlantic Monthly*, with the permission of the publishers.

that position, but as far as Russia in Europe is concerned it is doubtful whether the land is able to do more than support the existing population, provided it is adequately fed. Past surpluses for export were often accompanied by need on the verge of famine, and though better methods and organization might result in greatly increased production, it is hardly likely to keep pace with the growth of population. Russia in Asia is a more unknown factor, as are tropical South America and Africa, but we know enough to be able to say that they cannot be organized rapidly for the export of foodstuffs, as were the great prairies of Central North America. The gradual shrinkage of food-supplies relative to the consuming population was becoming evident in steadily rising prices from 1900 onward—a rise which is being again resumed after the wild fluctuations due to war, to boom and deflation. It was significant that even before the war the United States was being compelled from time to time to supplement by imports her production of corn, of wheat, and of meat; it is significant now that the new factor in the market to which some of the rise in wheat prices is attributed is an increasing volume of purchases from China and Japan. Scarcity will not come in a night; for a long time, as the Chicago operators say, wheat can always be found somewhere by scraping the bottom of the bin; but it is only prudent to calculate on a continued hardening of prices and the more frequent recurrence of panic rises, as a seasonal deficiency strikes a market denuded of reserves.

The orthodox economist will say at once that this situation will create its own remedy; under the stimulus of rising prices more people will be attracted into agriculture, production will be increased and the balance restored.

It has already been indicated that there is no new land very accessible; the settled countries possess no potential reserves, as may be seen from the way the United States has been driven to experiments in the reclamation of 'bad' lands, with no conspicuous measure of success. Nor as a rule do men who have once taken to urban life migrate back to the country because conditions are more promising; the tide sets always the other way, and if the agricultural population is to increase, it will have to be by its own growth. But here comes another factor into play: if food-production is diminishing, relative to population, so at the same time agriculture as a calling is losing in attraction relatively to industries and commerce.

The drift from the country to the town has been a secular subject of lament, needlessly so in so far as the movement is only the reflection of the fact that the land cannot carry more cultivators in one generation than another, when no change in the system of farming is going on. Son may succeed father on the land, but the second son must move off. There is no real need for lament if increased efficiency, due to the use of machinery, enables the same output to be attained with fewer men; the dangerous situation comes when the migration is caused by abandoned farms or a lower standard of cultivation. Now at the present time agriculture cannot compete with the other industries either for capital or for men, because it has not been, indeed cannot be in the nature of things, subjected to the speeding-up processes that have attended cotton-spinning, steel-making, or the like. All the world over, the capitalist farmer is not getting the same returns on his investment as is attainable in other industries; his prospects of expansion are poorer, his credit is inferior, and though he may stick by the farm his active-minded sons tend to seek other outlets. Financiers are not looking for farming enterprises, except as an elegant way of losing money in order to demonstrate their wealth. The peasant farmers, or rather their sons, are wondering whether the returns are worth the toil of such a life. Peasant farming has never yet succeeded in maintaining itself when it has been brought into such close contact with urban life that an escape was available.

Lastly, the wage-earners in agriculture are always the worst-paid class in the community. No farming enterprise, whatever the skill with which it is conducted, could earn for its workers the wage rates paid by Ford to his mechanics. In England the son of a farm laborer may be found on the railway, earning twice his father's weekly pay, though living under the same conditions and doing far less skillful work.

Here lies the real difficulty of the situation, that just when the world is needing increased food-production those very developments of science and organization which have caused population to expand are making life on the land less and less attractive. The town is becoming so much nearer; improved transport, education, the cinema, radio, are all elements in showing the country child the other sort of life and the way to it. Census returns, as far as they are available since the war, would seem to show an absolute as well as a relative diminution of the agricultural population in most of the civilized countries.

II

The only way out of the dilemma is, then, to find some way of raising the level of production on the land already in cultivation, since no great extent of new land appears to be available. At the same time the efficiency of the methods of production must be raised. Indeed the efficiency of the individual has to become such as will enable him to earn returns or wages commensurate with those obtainable in the industries; otherwise men will continue to drift away from the land.

First we may examine whether the level of production can be raised, and in this connection it is instructive to look back upon the history of English land.

In mediaeval times the average yield of wheat in England appears to have been in the order of eight or ten bushels to the acre; Walter de Henley explains that a threefold yield will not pay for the cultivation, and his anonymous contemporary says that wheat ought to yield to the fourth grain—that is, eight bushels for the two bushels sown per acre. This, then, was the level of production attained under the open-field system of winter corn, spring corn, fallow, where everything was taken away from the soil and nothing put back. Then followed the enclosures and the introduction of crops like clover and turnips, possible only when the land was in several ownerships and not thrown open to common grazing after harvest. Gradually too, under economic pressure, lands began to be thrown together, and the yeoman exchanged for the typical British farmer, occupying something between one hundred and fifty and four hundred acres—a process that was far advanced by the close of the eighteenth century. Under these conditions, with a rotation that included the recuperative clover-crop and turnips from which to make farmyard manure,—thus constituting a conservative cycle which put back everything to the soil except the corn and meat sold away from the farm,—a new level of production was reached. Arthur Young estimated the average yield of wheat at the close of the eighteenth century as twenty-four bushels per acre, but probably Lawes' estimate of twenty bushels per acre as the prevailing crop when he inherited his Hertfordshire estate, about 1835, is nearer the mark.

At any rate this new level of production, and the improved farming that accompanied the larger farming-units, proved able to furnish England with food during her first period of industrial expansion and increasing population. From 1840 onward ensued a new development; science began to be applied to the growth of crops and animals, artificial fertilizers and foreign feeding-stuffs became available, with the result that by 1870 a new level of production had been attained—of about thirty-two bushels of wheat per acre. It was not so much that farming-methods had been altered as that the fertility of English land had been enhanced by the fertilizers employed and the plant food that had been transferred to it in the shape of maize, linseed, and cotton seed, grown on foreign soils but consumed on English farms.

At that level of production, however, about thirty-two bushels per acre, English farming has stayed for the last fifty years. Indeed it has fallen away somewhat, for the arable area has shrunk and the present ploughland is the pick of what was formerly under cultivation.

This arrest in the upward march of the yield from the land was a response to the new factor that became operative in the middle seventies—the opening-up of the Americas and the flooding of the market with cheap wheat and other agricultural produce. The law of diminishing returns came into play; the English farmer could no longer afford to go out for such high yields. He had to cheapen his production, and this he could do only by reducing costs, for such reduction is not attended by a proportionate diminution in yield. The competition that was overmastering the English farmer was not due to bigger crops; it was the United States with

an average yield of thirteen bushels per acre or so, Canada with a little more, Argentina and Australia with less, that were underselling the producers of thirty-two bushels per acre. In order to keep his business going the English farmer had to move, not in the direction of bigger crops, but toward the methods of his competitors—cheap if slovenly farming, where the crop was left as much as possible to grow itself.

That a higher level of production is feasible over a great part of the world is easily evident.[1]

The potentialities of many American states with richer soils than those of Great Britain are obviously enormous; a doubled production is easily in sight. But as the law of diminishing returns informs us, such increased production per acre can be bought only at an enhanced cost per unit—per ton of wheat or per stone of beef. The cost will be in fertilizers and above all in labor, provided always that the system of farming cannot be changed to one of greater intrinsic efficiency.

On examination of this question of system we find that the greater part of the farming of the world is still done by peasants or, more exactly, on single-man holdings, large or small, where the work is carried out by the occupier and his family with only occasional help in seasons of pressure. Such peasant farming prevails generally throughout Europe and Asia, the exceptions being the great domain-farms belonging, as a rule, to the local nobility. Post-war legislation has in most cases aimed at breaking up these great estates; notable examples of this procedure may be found in Czechoslovakia, Rumania, and the Baltic States. Only in Great Britain and Southern Sweden is the prevailing type the middle-sized farm of one hun red to five hundred acres, as a rule rented, a depending for the actual cultivation on t hired labor of a wage-earning class. In t newer countries settlement generally begi with the creation of large pastoral estate some of which are afterward put under cu tivation as large productive enterprises. B as a rule closer settlement cuts the land u into blocks, into single-man farms of size d pending upon the land; and in South Ameri alone is the great capitalist farm the cha acteristic mode of handling the land. TI United States shows perhaps an intermedia state of organization; while the single-ma occupier-owner holding is typical, most farm ers employ some hired labor, though a d finite agricultural-laborer class does not e ist.

This peasant or yeoman form of landhol ing is generally regarded with favor, an many countries have adopted some form o legislation in order to foster it or to repa wastages. 'The land for the people' is a ways a good slogan for politicians; lan hunger is the most powerful of all passion to exploit. It produces a stable conservativ class in the community, hard-working an broken to labor, always regarded as the mo dependable war-material. It seems to prom ise the maximum of population supported b and living upon the land. Families run larg and furnish healthy and industrious recruit for the urban population, not excitable o easily moved by class agitation. From th time of Virgil and Horace the stury inde pendent peasant has always been the subjec of admiration and encouragement by liter ary men who love to contemplate honest to and the dignity of labor—in others.

III

But is this form of landholding economic and even effective in producing food for th community at large? Obviously when push ed to an extreme, so that the land availabl for each family becomes too small, the sur plus of food for sale after the needs of sub sistence have been satisfied is little enough This occurred in Ireland in the congested dis tricts and prevails in India and China today where agricultural populations of two and even three thousand to the square mile hover on the brink of starvation. It is not in it

[1] PRODUCTION OF WHEAT AND POTATOES, 1920-23

Quintals per hectare

	Wheat	*Potatoes*
Germany	17.6	121
Denmark	29.2	152
France	13.8	73
Great Britain	21.6	153
Russia	5.1	78
Canada	11.1	105
United States	9.1	70
India	7.9	—
Argentina	8.4	—
Australia	9.0	64

lf desirable that a maximum population ıould be engaged upon the land; in a self-ntained community the smaller the propor-on of the workers employed in the work of oducing necessary food the wealthier the mmunity, because thereby a greater number e set free to produce other items of wealth houses, boots, clothes, amusements—avail-le for distribution.

Among civilized nations to-day we may find much as half the population engaged in od-production, yet that proportion is ex-ssive unless the nation on balance is a rge exporter of foodstuffs. East estimates at in current Western agriculture 2.2 acres e needed to support one person; or one ndred acres will support forty-five persons, whom twenty may be reckoned as work-s. From other data we may estimate that ree workers could cultivate one hundred res of mixed farming-land and attain, un-r proper organization, the present level of oduction, in which case only one seventh the workers would be required to provide od for the rest of the population. In typi-l peasant countries like Italy or France rty per cent of the workers are engaged on the land, and as these countries are not mpletely self-supporting this disproportion itself would seem to demonstrate the com-rative inefficiency of peasant farming. In gland and Wales six per cent of the male rkers are engaged in agriculture, though ey produce only some forty per cent. of e food consumed by the total population. is agrees with the previous estimate that about one seventh of the workers were cul-ating the land they could feed the com-unity, provided they had an adequate sup-y of land. England and Wales could not fed merely by increasing the proportion farm workers from six to fifteen per cent, less at the same time additional land was ailable. But even on land of the average ality that is now under cultivation one ndred acres could be made to support more an forty-five persons on an ordinary West-n dietary, without departure from good rmal farming methods — that is, without ving recourse to the intensive production at is physically but not economically pos-le. The better-farmed land of England—t the whole cultivated area, but such as un-r present conditions could be four-fifths under the plough—requires no more than four workers per hundred acres and would feed a hundred persons on their produce. This is equivalent to saying that with proper farming only ten per cent of a total population need be 'on the land' in order to feed the rest.

On the score of efficiency it is often argued that the division of the land into small holdings is attended by an increase in its productivity. This is true, but only on the condition that such division is accompanied by a change to a more intensive method of cultivation. When an Australian pastoral estate, carrying perhaps a sheep to the acre, is laid out for closer settlement, grazing is exchanged for the plough and production increases. Similarly, when a dairy farm on the grass in the Vale of Evesham is cut up into small holdings of ten or fifteen acres, upon which men grow asparagus and other vegetables and fruit, the output from the land has been greatly enhanced, but the gain comes from the change of system, not from the size of the holding. In the same district are other larger holdings, as intensively cultivated as the small ones, and with greater efficiency as food-producers.

For obvious reasons the small farm is less efficient, less economic of human labor than the large one. It is handicapped physically in that the size of its fields does not permit of the effective use of machinery or the orderly disposition of labor. Overhead charges are high; the capitalization of the small farm is excessive. Economically the small farm is a weak unit for buying or selling, and though this handicap has been largely removed by co-operation in countries like Denmark, the handicap still exists. Intellectually the small farming community tends to become hide-bound and unprogressive; it is more difficult to carry enlightenment to it or to get new developments of science put into its practice.

It is, indeed, generally recognized that the peasant farmer maintains himself only by virtue of the hard work and long hours he gives to his holding. His day lasts from dawn to dark, and the work of his wife and children is freely thrown in. Moreover it is work of a different quality from the regulated pace of a trades-union laborer; often it becomes toil that ages and does not ennoble. What are the motives that maintain such a class?

Use and secular tradition count for much; in an old peasant community men feel they have a right to a piece of land—something inherent like the right to a 'soul' or a 'vote.' Then there is the desire for independence, to work without any man as master. There are always men who fit with difficulty into the organized framework of modern life, who cannot function as cogwheels in a machine. To them the peasant holding is worth while; indeed it is a necessary outlet if such men are to be made useful in society. Even where a larger system of farming prevails, as in England, small holdings are desirable as jumping-off places for men with little capital; they are the first rungs of the ladder up which many have ascended. For these privileges and opportunities men are willing to pay—to pay in labor out of all proportion to their immediate pecuniary return.

Given this deep-seated passion among men, cannot the business of food-production be with confidence entrusted to those who are moved by it, provided that steps are taken to allow it full development by facilitating access to the land? If the peasant population is to increase, more land must be found for it, and since there is now little marginal land not in cultivation the extension could be obtained only by taking land from the larger occupiers. We have already given reasons to suggest that this process would not be effective in increasing food-production. Further, it is difficult to suppose that peasant farming will continue to be attractive and that one group of men will be permanently content to work much harder than their fellows.

Viewed historically, peasant communities never appear to have been able to persist when brought into close contact with the town and against the competition of industries and commerce. Such was the story of early Greece and Rome, and later English agricultural history is a long lament for the decay of the yeoman. If peasant farming has been better maintained on the continent of Europe, it is because industrial life has remained more remote; only recently have other alternatives been available, and modern life is bringing them ever nearer. Peasant communities always carry certain seeds of decay—on the one hand the pressure to divide the holdings in order to provide for sons, on the other the land hunger that leads men to mortgage their holdings in order t extend their acreage. Many states have ha to adopt measures to preserve the small farm against the economic pressure that tends t absorb them in larger units. It was not s much robbery and oppression that deprive the poor man of his land in England, as th ordinary processes of sale or forfeiture fo debt. Nor did the latifundia bring abou the decay of the small farms of Italy—the were consequences and not causes.

If the peasant farmer is likely to be in adequate to the task of food-production, wha then is the alternative? In some way or othe the world must be fed; nor can we suppos that men, attaining even greater control ove processes and materials, will consent to l their development be limited by the primitiv and unorganized methods by which the agr cultural side of the community supplies th urban population with food.

IV

A century or more ago England's growin population, expanding as industrialism mad its first advances, was supported by the in creased productive power of the large farm that were being organized from the yeoma holdings. Progress in this direction is sti open and is much more likely to provide surplus of food than attempts either to in tensify the production on single-man farm or to add to the number of them. If th peasant becomes prosperous through risin prices, he does not to any extent set out t increase his output; his aim is less to mak money than to live comfortably. Nor, as w have indicated, is there much new land avai able for new settlement and increasing num bers. The way to enhanced production fro the land lies in the creation of large corpor tion farms, working with all the advantage of command of capital to turn the land to i fullest use, organization of labor, emplo ment of machinery, utilization of commerci and scientific knowledge.

The objection that the English farmer, wh has already proceeded along this path, ha been achieving no great success during th last half-century, even though he has bee enjoying his land at a non-economic rent, not really relevant. In the first place, th English capitalization, effective as it was i its day, has not gone far enough for moder

conditions; as an economic unit the average English farm is carrying too great overhead charges. When the farmer's function is that of manager only, it is not a man's job to control three hundred acres and to overlook eight or ten laborers, nor can such businesses be expected to yield the incomes that farmers have demanded from them. Secondly, the English farmer during this period has been struggling against the run of low prices due to the expanding farming-area and to the cutthroat competition of the unorganized peasant farmers. The necessary condition for the industrialized farm is the reëstablishment of prices that will permit of a commercial return on capital and of wages at something comparable to the industrial level, and this condition of higher prices is being brought about by the way the demand is increasing faster than the supply. The unit of farming should be something between two and ten thousand acres of mixed farming, and the management should be a hierarchy of director and assistants such as prevails in any great business. This of itself would present certain advantages, in that capable and educated young men would be recruited for farming even if they possessed no capital. At present farming is too much an hereditary affair; access is limited to young men to whom money is accessible, and the free entry of talent and brains is cut off.

The advantages of the large unit in economic production are various. It becomes possible to survey the area of land under exploitation and allot the varying land to its most suitable use. Large-scale enterprises for the amelioration of the land, such as works of drainage, soil improvement, reclamation of waste, can be undertaken. It is difficult, if not impossible, to secure such agreement among a group of peasant farmers as will enable a joint drainage scheme to be carried out and afterward maintained in efficiency; small men too are very averse to expenditure on any form of improvement, such as liming, of which the benefits are not immediately realizable. The management, again, can afford such aids to efficiency as a system of cost-accounting and with its help can direct the policy of the farm in accordance with the potentialities of the land or the tendency of the markets. Too often the farmer persists in a line of business that has ceased to be profitable, partly because he cannot count the cost, partly because he is not accustomed to consider alternatives. Again, the large corporation farm will have capital enough at its command to equip itself with adequate buildings, machinery, and appliances. More capital is needed in farming; as an example we can see all too many farms on which the buildings will hardly permit of the production of milk of the quality demanded by modern hygiene, yet if there were to be a drastic enforcement of sanitary conditions the milk-supply for the towns would be dangerously curtailed. And as with buildings so with such appliances as machinery and silos—neither has the small farmer the money wherewith to buy them, nor will the size of his business pay for so much locked-up capital.

Similar advantages are attainable in the organization of labor; there is room for specialization, and in all critical operations, such as sowing and harvest, a management that can throw a large staff on to a necessary job at the right moment is strongly armed against the vagaries of the weather. It would be superfluous here to go far into detail. The principles that govern the conduct of other big businesses apply equally to agriculture; farming can no longer be regarded as a 'mystery,' dependent wholly on the craft of the individual.

One must not, however, disguise the fact that there are many difficulties in the way before the large industrial farm can become general. Not immediately will there be available a race of managers who are capable of running such enterprises with success. Until some businesses of the kind have got going there are no training-grounds for future managers. However, the economic studies of farming that have been so considerably developed in both the United States and Great Britain within the last few years are providing data and criteria for scientific management. It may be urged again that labor difficulties will wreck the enterprise, that with the difficulty of supervision an adequate day's work can never be secured when the laborer is not working as one of a family group. British experience would show that this fear is hardly grounded. There is a danger perhaps that if industrialism becomes firmly entrenched in agriculture, and the laborers are organized into a powerful union, standards of hours, overtime, and the like would be set on lines completely inapplicable to farming. Agriculture must have its own special conditions of work; if cast-iron regulations

framed upon factory models are imposed, then all forms of farming based upon employment become impossible, as has been experienced in Australia. Probably the best prevention of labor troubles would be the introduction of an equitable system of profit-sharing, a procedure particularly applicable to farming. Not only is employment stable, for men naturally remain for long periods, if not their whole life, upon the same farm, but the work of the farm laborer is far more individual and responsible than it ever can be with the minder of an automatic machine. Profit-sharing may supply just that touch of personal pride and joint proprietorship which is the mark of the good agricultural laborer to-day, but which is tending to fade away under the modern organization of labor.

Over-capitalization may be dreaded. So often has it been seen that when the wealthy man embarks upon farming, his enterprise is crushed under the burden of doing things properly. He calls in a contractor where the workaday farmer makes shift with an old orange box and a bit of wire. But this is just where scientific as distinct from amateur management comes in; the trained director is not obsessed by the idea that he must have the best—he will set off probable returns against costs.

A more serious objection is that the land of most countries is already so parceled out that it will be well-nigh impossible to make up units of the desiderated size. Undoubtedly much English land is in need of reallotting. Boundaries both of farms and estates are capricious and inconsiderate of economic working; in some districts amazing anomalies exist, just as in others hedges and ditches occupy no small proportion of the available surface and, apart from the direct injury they cause to crops, cut the land into fields that are wasteful of time and labor.

How the remedy is to come about, by slow economic adjustment or by legislation, cannot be discussed; if the economic pressure grows severe enough the cure will be effected, just as the far more difficult transition from the common fields to enclosures was brought about a century or two earlier.

The first steps will be the most difficult, because in Britain, at any rate, the tradition is firmly established that no money is to be made out of farming except by the old practitioners in their retail way. Neither lawyers nor capitalists have any confidence in farming as a business, and though mon may be forthcoming for joint stock ente prises to grow tea, cotton, rubber, copra, a the like in the tropics, a similar venture England would find little support. This a ter all is a temporary phase, the result the falling prices of the last half-century a of the late development of systematic ma agement and administrative control in ag culture. If the prime thesis is correct, th food prices are rising and must continue rise as population tends to outstrip suppl the incentive to the entrepreneur and the i vestor will soon be supplied. The evoluti of agriculture toward the large industrializ farm devoted to economic production may delayed, but it must come, if for no oth reason than because it makes the most e fective use of man power, and man power becoming the most expensive item in co of production. Even in Britain, where t small farm is generally forced into a mo intensive form of agriculture and produc more per acre, the production per man—a therefore the surplus for sale—is greater the larger farms. How soon the change wi begin to be operative depends upon the cour of prices, but higher food prices must follo the inevitable growth of population, even for one unforeseen cause and another th lag behind expectations.

The peasant farmers cannot meet the d mand except by increasing in numbers a expanding upon new land, and no extensio of the agricultural area is now in sight su as took place during the last half of the nin teenth century. Moreover the peasant po ulation, with its standards of heavy wo and long hours, is being continuously unse tled by the increasing proximity of the tow by facilities of movement, and by the gro ing consciousness of labor conditions. can hardly be supposed that Western peopl will ever accept an Eastern mode of life- unlimited breeding, complete vegetarianism and endless subdivision of the land, with th creation of a serf-like agricultural commu ity, existing on the verge of starvation. The will insist upon their own standard of livi and limit their numbers, whereupon the on way of getting the maximum of food-produ tion for the urban population will be to mak the individual worker as effective as possib by becoming a unit in a large organizatio armed with all the resources that machine and science can give him.

The Determination of the Origin of Agricultural Seeds with Special Reference to Red Clover.

F. T. WAHLEN

Chief Seed Analyst, Dominion Seed Branch, Ottawa

INTRODUCTION

The superiority of home grown seeds over imported seeds has been demonstrated in nearly all countries and for so many kinds of crops that enumeration of the experiments would lead too far. It may merely be stated that results of comparative field tests are more strikingly in favour of home grown seeds in countries with a cold climate, as would be expected, and this is the reason why the slogan "Use Home Grown Seeds" is often changed to the broader term "Use Northern Grown Seeds". A condensed result of the above mentioned experiments is the open discrimination against southern grown seeds which finds its expression even in the seed control legislation of some of the countries which are recognized as leaders in this matter.

The possibility of determining the origin of a given sample by means of its impurities and other characteristics is of two-fold interest to Canadian agriculture. First, it would serve as a means of protecting our farmers against imported southern grown seeds, and further it would afford a protection to Canadian grown seeds on foreign markets which should not be underestimated. Seeds produced in Canada command a good premium on many markets and it is important to have means for identifying the origin other than the statements on the invoice. For some kinds of seeds a great deal remains to be done before it will be possible to detect the origin of samples with reasonable accuracy; the problem is nearer a solution, however, for red clover and alfalfa, two of our most important forage crops.

Review of Literature

Nobbe (13) was the first to point out that the weed seeds in a sample could be used as a clue to its identify. Burchard (2) published further data in this respect, and Stebler inaugurated the determination of the origin of red clover samples as part of the service of his seed testing station. He later published lists of so-called "leading species" for different countries (17), i.e. species with a limited geographical distribution which, by this very fact, can be used as clues for origin tests. In conjunction with Schröter (18) and later Volkart (19), he added a great deal to our present knowledge on the subject. Oberstein (14), Frank and Wieringa (5), Parkinson and Smith (15) have made further contributions in this connection, while Müller and Rohlfs (12) and Lakon (8) treated red clover produced in southern Germany and Italy respectively. Hillman and Henry (7) determined the weed seed content of Italian grown alfalfa and red clover and to François (6) we owe a plant geographical study of the weed flora in France with reference to the possible weed seed content of French red clover.

Lately Volkart (21) has pointed out that errors are likely to occur if the leading species alone are considered and he has urged the necessity of a survey of all characteristics such as mineral and animal impurities, grain weight, colour, etc. Such a survey is at present being carried out by the International Seed Testing Association.

The Role of Plant Geography

The determination of the origin of seeds is partially a problem of plant geography. Partially, we say, because the weed seed content is not purely a function of climate and soil, but also of methods of cultivation, harvest, cleaning and other factors. It is important, for instance, whether the seed be harvested from the first cut, which practise is often employed for late red clover on account of its scant development of second shoots, or from the second cut, which is common practise in most countries. Further, the process of seed cleaning has been perfected to such an extent that by the time

a sample reaches the analyst it contains nothing but the fragment of a weed flora, so that these clues have to be supplemented by other characteristics in order to enable a reliable origin test. On the other hand, cases have been reported where certain weed seeds suggestive of an origin heavily in demand have been intentionally added*, and finally the analyst has to contend with the problem of blended lots of different origin.

The opinion has often been expressed that the leading species will in time become worthless as clues because of the international trade in seeds. Although the geographical ranges of many plants have been widely changed through human agencies, this contention is not so well founded as might appear. It is interesting to note, for instance, that many weeds characteristic to North America have never become established in Europe. This is mostly due to the fact that these species are unable to ripen their seeds early enough to be propagated under European climatic conditions. Most American weeds, especially the annuals, germinate only under a relatively high temperature of the soil such as prevails in continental climates early in spring due to the sudden change from the cold to the warm season. Thus such characteristically American weeds as *Ambrosia artemisiifolia L., Plantago Rugelii Desn., Plantago aristata Gray, Physalis lanceolata, Michx.*, and *Panicum capillare L.*, may occur as ephemeres in Europe but will never become established on cultivated land. Southern species when introduced into northern zones may germinate in the field but are mostly unable to reach the flowering stage because they are quickly oppressed by the vigorously growing crop. Such is the case with *Centaurea solstitialis L., Arthrolobium scorpioides* D.C., *Helminthia echioides* Gärtn. etc. The *Cuscuta* spp. offer a very interesting example in this connection. We can distinguish three different zones, viz.—a southern zone in which the dodder seeds freely and ripens its seeds regularly, a central zone in which seed in produced but in most years it does not reach maturity and will not germinate, and a northern zone into which dodder may occasionally be introduced but where seeing occurs rarely and ripe seeds are nev produced. Degen (3) has shown that apa from the mean annual temperature the a nual total precipitation is a very importa factor for the distribution of dodder, 10 mm. being the upper limit for its existen under thriving conditions. This seems to a ply at least to *Cuscuta trifolii.*

Comparative investigations into the we seed content of samples originating in sm districts have never been conducted, so th there are no exact data available as to t influence of the chemical and physical n ture of the soil. If the seeds of species li *Medicago lupulina, Daucus carota, Sheradr arvensis* and *Anagallis arvensis* occur in lar numbers we can draw conclusions not on as to the nature of the climate in the count of origin, but we know that the seed w produced on a soil rich in lime. On t other hand, samples infested with *Holc* spp., *Rumex acetosa* and *acetosella* and othe would point to an acid soil. However, the observations have little practical value wh it comes to the actual determination of t origin because geographical factors* Warming's (22) sense overshadow top graphical factors entirely. For this a other reasons, it is impossible to apply practical advantage in origin test the fu amount of material made available throu modern studies in ecological plant geograph

As a whole it may be said that the we seed content of a sample is still the safe guide for the determination of its origin, a though results can only be conclusive if number of other characteristics are conside ed along with the weed seed content. So of the most suggestive weed seeds are fr quently present in small numbers only, whi means that from 200 to 500 grams should analyzed for such a test. The following a some species suggestive of south Europe origin:

Arthrolobium scorpioides Dec.
Centaurea solstitialis L.
Tunica prolifera Scop.

* Börger (1) cites an instance where a seed firm was on the market for seeds of *Silene dichotoma Ehrh*, at this time considered a leading species for Russian red clover seed which sold at a high premium.

* Warming understands with Drude, under ge graphical factors, such factors that work ov great areas, like light, temperature, atmosphe precipitation, humidity and the movements the earth, while topographical factors in t sense apply to the chemical and physical prope ties of the soil.

Cephalaria transylvanica R. S.
Centaurea jacea L.
Torilis nodosa Gärtn.
Ononis repens L.
Daucus carota L. (if present in great numbers.)

Almost entirely limited to Italian seeds are *Hedysarum coronarium* L., *Centaurea calcitrapa* L., *Picris stricta* Jord. *Phalaris paradoxa* L. *Trifolium supinum* Savi occurs also exclusively in Italian red clover seed according to François (6). It had been claimed that this species had also become established in France, but from a large amount of evidence gathered by François, this seems improbable. Hillman and Henry, in addition to four of the above mentioned species, list a *Galega* and a *Valerianella* spp. as typical of Italian seed.

Red clover originating in eastern Europe shows the following typical impurities:
Hibiscus trionum L.
Delphinium consolida L.
Nigella arvensis L.
Lythrum hyssopifolium L.
Ballota nigra L.
Glaucium corniculatum Curt.
Sideritis montana L.
Hyoscyamus niger L.
Papaver somniferum L.
Conium maculatum, L.
Galega officinalis L.
Anthemis austriaca Jacq.

Silene dichotoma Erh. is an example of a weed which had been limited strictly to one country, namely Russia, but has spread rapidly over the whole central part of Europe. It may be expected that the relative prevalence of dodder will furnish a valuable clue for the distinction of red clover samples originating in the different localities of eastern Europe. According to Degen (3) dodder occurs in the whole of Hungary, but is limited to very distinct zones in Russia.

Origin determinations of red clover seed grown in western Europe offer more difficulties because the occurring weeds have a rather wide geographical distribution. More or less characteristic are the following:

Valerianella Morisonii D. C.
Verbena officinalis L.
Brunella vulgaris L.

and for English seed especially:
Geranium dissectum L.
Geranium pusillum L.
Sherardia arvensis L.
Lychnis alba L.
and a *Trifolium species.*

Red clover produced in central Europe is mainly characterized by the relative absence of species suggestive of other origins and the presence of accessory species well adapted to a moderate climate with high annual precipitation.

Chilean seed is characterized by *Cuscuta racemosa* Mart. (very prevalent), *Ami visnaga* L., *Melilotus parviflorus* Desf., a *Brassica* species and *Medicago denticulata* Willd.

Species suggestive for North American origin are the following:

Ambrosia artemissifolia L.
Plantago Rugelii Dcne.
Panicum capillare L.
Setaria viridis and *glauca* (L) Scop.
Digitaria sanguinalis (L) Scop.
Potentilla monspeliensis L.
Plantago aristata Michx.
Amaranthus retroflexus L.
Paspalum laeve Michx.
Lepidium virginicum L.
Physalis spp.

Canadian samples produced in the eastern provinces in particular are characterized, in addition to the above mentioned species, by very frequent occurrences of *Trifolium hybridum* L., *Phleum pratense* L., *Melilotus alba* Desv., and *Melilotus officinalis* (L) Lam.

I have stated that it would lead to errors to rely entirely on the leading species which have just been enumerated. All other weed seeds present in a sample must also be considered and may serve as valuable guides because of their respective prevalence. A large number of species which are found almost regularly in commercial samples will be found omitted in the preceding lists because they are too cosmopolitan to serve as a clue. Such is the case with *Rumex obtusifolius* and *crispus*, *Rumex acetosella*, *Plantago lanceolata*, *Chenopodium album* and some *Silene* spp.

The Colour of the Seed

The colour of the individual seeds of red clover varies from pure yellow to yellowish-purplish or mottled to a dark purple. This variation in colour is probably an inherent character according to Malte (8) who cites Kajanus and Gmelin in support of his views. Martinet (11) has arrived at similar conclusions. This would explain the fact that the respective prevalence of yellow and purple varies with the origin of seeds, because, as Malte (9) says: "Especially in such European countries in which red clover seed growing has been practised for a long time, a great number of local varieties have been more or less unconsciously developed through a process of natural selection."

It is rather difficult to compare figures in the literature on the subject because the colour classes have been grouped from different standpoints and even where attempts at uniformity have been made the individual judgment of the investigators plays a great rôle when it comes to making the finer differences. Chilean, Italian and central European samples show more yellow or predominantly yellow seeds than French and Canadian samples. This aplies to the ordinary commercial samples only. Special strains produced in the different countries may show colour characteristics differing widely from the general average. In Alta-Swede red clover, for instance, the yellow predominates to a remarkable extent. Stebler and Volkart (19) have made a simple classification into yellow and predominantly yellow and purple and predominantly purple, leaving out entirely the intermediate colour grades. They give the respective proportions as 40.7% and 18.5% in Italian seed and 21.2% and 31% in French seed, while the other "nationalities" range between these two extremes. This seems to afford an excellent criterium for the distinction of French and Italian seeds, two origins otherwise not very readily distinguishable. Dymond (4) gives the following distribution of colour for Canadian red clover seeds:

Purple seeds	21.6%
Yellow seeds	21.3%
Intermediate	51.9%
Brown	5.1%
Green seed	.1%

In our investigations 1000 grains contained, on an average of 100 determinations on samples harvested in 1923 in the province of Ontario, the following proportions:

Yellow	218
Yellow predominating	276
Intermediate	243
Purple predominating	208
Purple	13
Brown	42*

The Thousand Kernel Weight

The weight of a given number of seeds is very variable. According to Malte (10) and others it varies highly with individual plants. Malte has found that in 250 samples collected from individual plants in Quebec and British Columbia the variation extended from 118 to 252 mgs. for 100 seeds. In spite of such individual variations the weight of the grain is sufficiently different in commercial samples to allow of conclusions as to their origin. Even the process of cleaning does not appreciably affect the average thousand kernel weight because the degree of cleaning is economically limited, in other words the waste must not exceed a certain proportion. The thousand kernel weight is to a certain extent a function of the climate. Countries with a long period of vegetation produce heavier seeds than zones where the growth is limited by either hot, dry or cold weather. We have found that Canadian red clover in commercial samples weighs on an average 1.457 gr. per 1000 kernels, the range of variation extending from 1.359 to 1.534 (harvested in 1922 and 1923). Dymond (4) has found 1.522, 1.280 and 1.955 gr. respectively on samples produced in 1916. This shows that the variation from season to season may be considerable. The average is probably about 1.500 gr. which figure corresponds with the one given by Stebler and Volkart (19). English seed weighs, according to Stapledon (16), as high as 2.08 gr. and as low as 1.730 gr. while Chilean seed is even heavier with 2.24 gr. Italian seed is comparable in weight with Canadian seed and French red clover is slightly heavier, ranging between Italian and Eng-

* These determinations were made according to the colour standards distributed by Volkart on behalf of the International Seed Testing Association and the results can in no way be compared with those obtained by Dymond

Percentage by Weight of Seeds

	Chilean	British (1)	British (2)	Canadian	French	Italian
Seeds retained ...	73.4	66.6	55.	20.6	18.	20.
Seeds passed	26.6	33.4	45.	79.4	82.	80.

lish seed. Thus it is easily seen that differences are appreciable enough, although the weight overlaps in a few instances and individual samples may vary even more.

Stapledon (16) has used a quicker method for the determination of approximately the same factor by passing the samples over a 1.5 mm. sieve and weighing the proportions of seeds passing the sieve and retained by same. The above table given by this author shows that the differences are even more pronounced than in the thousand kernel weight.

It may seem surprising that the difference between the English seed on the one hand and the Canadian, French and Italian seed on the other hand is so great, although the 1000 kernel weight shows a lesser spread. The reason for this is the large proportion of brown, flattish, light seeds in English samples. These seeds, although being poorly developed, are approximately of the same size as the normal kernels and, while lessening the thousand kernel weight, do not affect the proportion of seeds passing through the 1.5 mm. sieve. This characteristic of English seed helps to distinguish it from Chilean seed which otherwise is of quite similar appearance.

Mineral Impurities as Characteristics

The rôle of mineral impurities in origin tests has not yet been thoroughly studied. Red clover grown in southern Russia will always be found to contain particles of black soil. The same may apply to Hungarian and Roumanian seed. Inasmuch as typical black soils (tschernosiome soils) are a function of the climate, this impurity is indicative of seeds grown under semi-arid conditions.* A parallel to this is the occurrence of particles of red soil (laterite) in alfalfa produced in Languedoc, France, which serves as a means of distinguishing this seed from alfalfa grown in the Province (19). The latter is said to be a superior strain. Tryti (20) has found that the character of sand-grains is a useful guide for the distinction of Norwegian from central European red clover.

Vegetable and Animal Impurities

The same author (22) states that he has made use of particles of leaves and stalks as a means to detect American origin. He was guided by the hairyness of these particles and it is probable that the same characteristics would be found in all samples originating in a dry, continental climate.

Stebler and Schröter (18) have found that *Helix acuta*, a small snail, is a very reliable means of detecting sainfoin produced in southern France. The same applies to a lesser degree to *Helix ericetorum* and François (12) adds *Helix variabilis* to this list.

Other Characteristics

Lately, precipitative reactions have been applied to the determination of the origin and although conclusive results have not been obtained there is some promise that progress may be made. Pethybridge has found that seeds of wild English white clover contain an agent which has the property to free prussic acid. By this means samples of this seed are readily distinguishable from the ordinary white clover in the trade.

A newly invented process for separating dodder seeds from red clover and alfalfa affords a very interesting means for an indirect determination of the origin. A dry magnetic material, probably magnetic iron oxide, is applied to the seeds which are then subjected to a magnetic separation process by which the seeds with a rough surface to which the iron oxide adheres are separated from the other seeds. To judge from numerous samples which passed through our laboratories the process is mainly applied for the elimination of large seeded dodder (*Cuscuta race-*

* According to Hilgard, Wiegner, Stremme and others, tschernosiome soils are only found in areas with an annual precipitation of from 15 to 20 inches.

mosa Mart.) which is very prevalent in Chilean seed. Of sixteen samples tested in Ottawa during the seed testing season 1924-25, all but one contained typically Chilean weed seeds. It is not possible to remove all traces of iron oxide after the process of cleaning, so that a qualitative iron test with potassium ferricyanide in a slightly acid solution will tell readily whether a suspected sample was passed through this process and this allows at least an inference that the seed contained originally dodder and was produced in a zone having favourable conditions for this dangerous weed.

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The Present Status of the Barberry Eradication Campaign in Western Canada.

V. W. JACKSON, W. P. FRASER and D. L. BAILEY

The Dominion Department of Agriculture as well as the Departments of Agriculture of the three western Provinces, Manitoba, Saskatchewan and Alberta, have been giving some attention to the project of barberry eradication for the past eight years. The closest possible cooperation has existed among the various agencies throughout the campaign. Up to the present, however, the results obtained have never been brought together and correlated. This seems desirable, not only that we may know what has been accomplished; but that we may get a better idea of what still remains to be done and the manner in which this may be most effectively carried on. Accordingly the following summary has been prepared. In it Professor V. W. Jackson of the Manitoba Agricultural College, has outlined what has been accomplished through the various provincial agencies in Manitoba, while the other phases of the work have been summarized by W. P. Fraser for Saskatchewan and by D. L. Bailey for Manitoba.

I.—The Eradication of Barberries in Manitoba

(a) BY PROVINCIAL AGENCIES

Following the rust epidemic of 1916 which was generally conceded to have destroyed half the crop, much interest was taken in all means of controlling such a serious menace.

To facilitate legislation barberry was added to the Noxious Weeds Act. At that time Manitoba had a well organized Weed Commission with three commissioners and an inspector in practically every municipality.

The Botany Department of the Agricultural College undertook to make a survey of the nurseries of the West, and to locate and make an estimate of the number that had been sold. It was found that most of the barberries were in city parks of Winnipeg, over 3,000 in all, which Professor Buller urged be removed, and which the Parks Board promptly did in the spring of 1917.

It was found that the nurseries outside of Winnipeg had very few on hand, and that they had never sold very many, perhaps not over 3,000 throughout the West, as can be seen from the following report:

Location of Barberries in the Prairie Provinces in 1917

MANITOBA

Winnipeg—3,000 in City Parks, 12 at M.A.C.

Brandon—25 bushes in the Patmore Nursery and three at the Experimental Farm. Sold from the Patmore Nursery less than 200 in twenty years.

Morden—25 in the Pine Grove Nursery.

Portage la Prairie—Island Park Nursery never sold barberry and none on hand.

Valley River—8 in the Boughen Nursery.

Dropmore—300 in the Skinner Nursery.

SASKATCHEWAN

Indian Head—About 200 in Forest Farm. 3 in Experimental Farm.

Regina—About 300 in Park in Central part of city. On Parliament Buildings ground about 75.

Saskatoon—Five on University grounds. A dozen at Glencairn Farm.

Estevan—Prairie Nurseries 300 purple leaved barberries on hand.

ALBERTA

Coaldale—The A. Mitchell Nursery Co., 20 bushes on hand, and "not more than 100 in the whole Province." (?)

Practically all of these reported in Manitoba were removed in the summer of 1917 or the following year. The nurserymen responded freely as there had never been much sale for them, and they were not in favor on the nurseries. According to the nursery books not many had ever been sold,—not more than 1,000 in Manitoba outside of Winnipeg.

Eight years of search has verified this estimate. Forty-five weed inspectors have reported and removed less than 100 barberry shrubs. The C.P.R. removed fifty-four barberry shrubs found at Portage station 1918, and offered to remove any more found at their stations; but no more were found. The Manitoba Agricultural College kept six demonstration shrubs (by special provision of legislature 1917) to show students the shrub and request a report of its discovery in the Province. An average of fifty students per year send in sixty plants each and yet we have not got a single authentic report of barberry by this means. During the rural survey of 1921, barberry was on the questionaire; but no shrubs were found in a house to house survey of 15 townships. Thirty thousand weed and rust bulletins with photographs of barberry have been distributed throughout the Province, and the public must be fairly well aware of the menace of this shrub, and of the necessity of reporting or eradicating it. There has been hearty co-operation wherever requests have been made.

As the Noxious Weeds Act did not apply to the city of Winnipeg, requests were made for removal through the press and by personal solicitation in known cases, but a house to house survey was left to federal officials operating under the Destructive Insects and Pests Act, and since 1922, 140 barberry shrubs have been located in Winnipeg and all have been eradicated. Officials on rust survey work are constantly on the look-out for barberry; but very few barberry shrubs have been located around country homes.

There remains the question of wild barberry. We have no record of wild or naturalized barberry in the Province. During the eight years our six shrubs have been under observation, we have never found any seedlings coming up around the shrubs or from seed sown in the adjoining woodland. In 1917 a survey of the Riding Mountains was made where ecesis of barberry would be more favorable than in the Red River Valley; but no wild barberry was found. A report from the Tiger Hills turned out to be Buffalo-berry. Radio calls have been made, offering $50. for wild barberry. Many specimen twigs have been sent in, but none were barberry. The fact that barberry has become naturalized a short distance south of the International boundary leads us to suspect that it might be growing wild, within our limits, especially in the Pembina Mountains where conditions are more favorable. But there are many plants that stop just South of the boundary,—e.g. ginseng, sumach, pin oaks, leatherwood (*Dirca palustris*), blackberry dogwood (*Cornus alternifolia*), and on the age and area hypothesis we might reasonably expect that barberry has not been sufficiently long naturalized to the south of us to have spread this far north. On the other hand barberry is spread by birds carrying the seed, and we have cases where birds have extended the bounds of a tree or shrub hundreds of miles north of the normal range, e.g. a dozen Hackberry trees (*Celtis occidentalis*) at the Delta, Lake Manitoba and scattered sumach (*Rhus glabra*) in the Pembina Mountains, and Grand Beach, Lake Winnipeg. So that no doubt barberry seeds are brought northward by the birds. Will the seeds germinate and winter through in this latitude? Last autumn Dr. D. L. Bailey found tiny seedlings growing where a barberry hedge had been recently removed, on our southern boundary. This is our only record of seedlings, and their fate this winter will be awaited with much interest.

(b) BY FEDERAL AGENCIES

(1) Survey Results

By an amendment to the Destructive Insect and Pest Act the barberry was outlawed throughout the three prairie provinces in 1919 and legal machinery thus instituted providing for its compulsory eradication without compensation, wherever it was found. Each summer from that time on, survey work has been carried on in Manitoba under federal auspices. As a result of these activities the cities and towns of the Province have all been systematically surveyed, as well as the villages in as far as this was warranted by local conditions. Barberry plantings were found only in the following places: Winnipeg, Portage, Brandon, Gimli, Morden, Shoal Lake, Carman, Stonewall, and Melita. In the majority of villages and towns an altogether regrettable lack of interest in shrubs of any kind was much too apparent. With the exception of those in Winnipeg, the plantings which were located were limited to a

few bushes each. One eighty foot hedge was found at Gimli.

No systematic survey of rural districts has been undertaken up to the present. Each summer, however, the scouts engaged in rust survey work and the men engaged in potato inspection work have been made familiar with the barberry and have been instructed to keep a careful look-out for it in rural sections. As a result of these activities together with reports from outside sources, two rural plantings were located. These consisted of a hedge at Snowflake, and a single bush at Rathwell.

The eradication of the bushes located has kept pace with the survey work, with the result that all the plantings which have been located have been removed. In addition a re-survey has been made of all these locations to make sure that the job has been well done and to remove sprouts wherever these appeared. As far as has been observed the barberry does not find conditions in Western Canada congenial. In every case there has been evidence of serious winter killing and a general lack of vigor. When once they have become established, however, they appear to persist almost indefinitely in this reduced state. They are easily disposed of by one thorough digging and repeated observations indicate that the subsequent appearance of sprouts in such instances is not at all a serious problem under our conditions.

(2) Relation to Rust

Wherever barberries have been located in Manitoba they have been found rusted. The infection ranged from light to extremely heavy according to local environmental conditions. Consequently, every single barberry planting in Manitoba must be regarded as a potential menace, capable of initiating a rust epidemic of unlimited intensity and extent when the requisite favorable weather conditions are at hand at the proper time. Therefore, the eradication of the last barberry shrub in Manitoba must be our aim.

While the potential danger of barberry plantings in Manitoba cannot be denied, it must be admitted that we have not been able to accumulate concrete evidence indicating that observed plantings have had any significant part in instituting either local or general epidemics. Rust is relatively late in appearing on barberries here and environmental conditions are apt to be quite unfavorable for the spread of rust at the time infection first takes place. In any case the results have always been the same up to the present—the spread of rust from barberries can be traced at the most only to immediately adjoining grasses before the whole district and adjoining ones are involved in a general epidemic which is not local in origin. Subsequently it becomes very difficult to determine just what role rusted barberries or uredinial infections started by them are playing. There has not been the clear-cut evidence one would expect to indicate that this role was significant. However, the number of cases under observation has been very limited, the plantings at Gimli, St. Charles, Manitoba Agricultural College and Snowflake being the chief ones.

II.—The Eradication of Barberries in Saskatchewan and Alberta

(1) Survey Results

A total of eighty-nine cities, towns and villages have been surveyed in Saskatchewan. This includes most of the centres having a population of 300 or over, and some of the smaller villages as well. Rural survey has not been systematic but has been done to some extent in connection with rust survey and potato inspection work. Barberries were located in eleven localities as indicated in the accompanying table. They have all been eradicated. In Saskatchewan, M. P. Tullis of the Provincial Department of Agriculture, took an active interest in the survey for and the eradication of barberries. Removal of the barberries in the city of Regina and a few other places was due to his activity.

Barberry Plantings Located in Saskatchewan

Battleford—12 ft. hedge, 2 bushes.
Glencairn (near Saskatoon)—12 shrubs.
Imperial—1 shrub.
Indian Head—About 50 shrubs.
Moose Jaw—26 shrubs.
N. Battleford—3 shrubs.
Outlook—37 shrubs.
Prince Albert—7 shrubs.

Regina—100 shrubs and hedge of about 180 feet.

Rosthern—3 shrubs.

Saskatoon—28 shrubs.

In Alberta only a few places were surveyed. Since rust is less serious in Alberta than in the other provinces most of the attention has been given to Saskatchewan.

(2) Relation to Rust

In the central and southern parts of Saskatchewan barberries rusted very heavily. In northern Saskatchewan, e.g., at Prince Albert and Battleford few or no aecia were found on barberry. Generally little or no rust developed on barberries when they were located in open exposed places, but infection was usually pronounced when they were in sheltered places.

Opportunities have been limited for studying the spread of rust from barberries. The following is a summary of all of the cases where such observations were possible.

Indian Head, 1917, Forestry Farm—About 50 shrubs were heavily infected. Rust spread to grasses near, chiefly *Agropyron tenerum, A. Smithii, Elymus canadensis, Hordeum jubatum.* The extreme spread of rust on the grasses was about 400 yards. By this time rust was appearing here and there over the wheat fields in the districts. The nearest wheat field was about 550 yards distant, but rust did not appear earlier in this field, nor was it more severe than in the neighbouring fields or districts. The weather was very dry.

Indian Head, 1918—Ten shrubs in the village were heavily rusted. Rust spread to *Agropyron tenerum* and *Hordeum jubatum* near, but could not be traced further than about 20 feet. Few susceptible grasses were near.

Glencair Farm, 1922 (near Saskatoon)—A few straggling and half dead bushes were moderately infected. Rust spread to neighbouring susceptible grasses and to a distance of about 100 yards, chiefly on *Agropyron tenerum* and *Hordeum jubatum.* It was not traced further. By this time rust was general over the surrounding fields.

Saskatoon, 1923—Thirteen shrubs in Mayfair Park showed marked infection. The earlier aecia were well opened and spores shed when barberries were removed. *Hordeum jubateum, Agropyron tenerum* and *A. Richardsonii* were abundant near the shrubs and for several hundred yards around. Heavy infection followed on these grasses and extended for about 500 yards. One pustule was found on *Hordeum jubatum* about half a mile distant. No rust could be found on barley about three-quarters of a mile distant at this time. No wheat fields were within about two miles. Rust developed no earlier on these wheat fields or on the barley than in fields far removed from the city, that is till rust was general over the district. The conditions were very favourable for the spread of rust. The season was wet and susceptible grasses were near, but no evidence could be secured of direct spread to grain.

From this data it is evident that barberries may become infected very generally in Saskatchewan. Consequently there is the possibility that they may prove destructive under suitable environmental conditions and this consideration alone justifies their complete eradication. This is justified also as a safeguard for the future.

New Zealand Appointment

The Logan Campbell Chair of Agriculture at the Auckland University College, New Zealand, which was advertised in this magazine early in the year, has been filled by the appointment of Mr. William Riddet of Scotland.

Calcaires Magnésiens versus Calcaires Purs, comme Amendement des Sols.

H. M. NAGANT

Professeur à l'Institut Agricole d'Oka

Role de la Magnesie dans la Vegetation

Il est bien connu, de tous les agronomes, que la magnésie est un principe indispensable à la nutrition des plantes, au même titre que la chaux. Aussi retrouve-t-on, d'une manière constante, dans toutes les cendres provenant de l'incinération de matières végétales une proportion relativement élevée de magnésie, se rapprochant assez souvent de celle de la chaux.

C'est ainsi que, d'après Muntz et Girard, une récolte moyenne de betteraves sucrières enlèverait au sol 53.33 lbs. de magnésie contre 51.21 de chaux par âcre. Tous les sols doivent donc contenir un certain approvisionnement de composés de magnésium pour subvenir aux besoins de nutrition des récoltes.

D'un autre coté, il faut se rappeler que la magnésie est un principe basique, comme la chaux, et qu'à ce titre elle contribue, aussi bien que celle-ci, à maintenir la réaction du sol neutre ou légèrenent alcaline, ce qui lui donne les qualitiés d'un amendement.

Le rôle physiologique de la magnésie, comme celui de la plupart des éléments minéraux d'ailleurs, n'est pas parfaitement compris encore, cependant certains savants, tels que Willstätter, par exemple, pensent que ce principe exerce une action importante, comme élément catalytique, dans le phénomène de l'élaboration chlorophyllienne, c'est-à-dire dans la conversion du gaz carbonique de l'air en hydrates de carbone ou sucres par la substance verte des feuilles, qui porte le nom de chlorophylle.

Quoiqu'il en soit, on a toujours constaté que la magnésie se localise principalement dans les graines des plantes, où elle se trouve combinée surtout avec l'acide phosphorique, tandis que la chaux est plutôt répartie dans les tiges et les feuilles.

C'est ainsi que le grain de blé, par example, contient en moyenne 0.22% de magnésie et seulement 0.06% de chaux, tandis que dans la paille de la même céréale on trouvera 0.11% de magnésie et 0.26% de chaux.

Rapport de la Chaux à la Magnesie

Toutefois il semble nécessaire qu'il y ait un certain rapport entre les quantités de magnésie et de chaux existant dans la solution nutritive qui se trouve en contact avec les racines des plantes en croissance pour que celles-ci se développent normalement. Un savant du nom de "Loew" trouva, en effet, que les deux principes minéraux pris isolément sont toxiques pour les végétaux et que ce n'est que lorsque les proportions entre la magnésie et la chaux tombent entre certaines limites que la toxicité disparait.

La raison de ce fait est inconnue mais suivant certaines expériences le rapport optimum (le plus favorable), entre les quantités respectives de chaux et de magnésie en solution, varierait entre une unité moléculaire en poids de chaux à une de magnésie et sept unités moléculaires en poids de chaux à de magnésie, suivant les plantes considérées. Ces considerations préliminaires étant faites, voyons ce que l'on entend par: calcaires et chaux magnésiens.

Calcaires et Chaux Magnesiens

Un calcaire magnésien est tout simplement une pierre à chaux dans laquelle une partie du carbonate de chaux est remplacée par du carbonate de magnésie; lorsque les proportions moléculaires entre les deux sortes de carbonates deviennent égales le calcaire prend le nom de dolomie ou calcaire dolomitique. Parfois le carbonate de magnésie se substitue presque entièrement au carbonate de chaux, dans la roche, qui devient alors de la magnésite ou giobertite.

On voit donc qu'il peut y avoir entre le calcaire pur et la magnésité toute une gamme de pierres à chaux plus ou moins magnésiennes et que la calcination de ces matériaux pro-

duit, nécessairement, aussi plusieurs variétés de chaux: grasses, magnésiennes et dolomitiques allant jusqu'à la magnésite calcinée.

Un examen sommaire permet déjà d'identifier un calcaire fortement magnésien ou une dolomie, au fait que, contrairement aux pierres à chaux purement calciques, ils ne bouillonnent pas ou presque pas au contact des acides a froid et ne s'y dissolvent qu'à la faveur de la chaleur.

Observons aussi immédiatement que parmi les gisements de pierre à chaux de la province de Québec, pouvant servir éventuellement à l'amendement de ses terres, on rencontre toutes les variétés de roches calcaires, depuis les carbonates de chaux les plus purs jusqu'à la magnésite proprement dite.

Appartenant aux variétés pas ou peu magnésiennes dosant de 80 à 98% de carbonate de chaux, sont, généralement, les calcaires des formations géologiques dites de Chazy et de Trenton, dont on trouve de nombreux affleurements suivent une bande de territoire s'étendant depuis la région d'Ottawa, Montréal, jusqu'au delà de la ville de Québec, en suivant le rive nord du fleuve St. Laurent.

Par contre, les calcaires de la formation géologique dite "Calcifère", qui constituent le sous-sol sur de grandes étendues des comtés de Chateauguay, Beauharnois, Huntingdon, et Vaudreuil, par example, sont ordinairement fortement magnésiens, fait déjà connu des géologues et encore confirmé par les analyses effectuées au laboratoire de St. Hyacinthe, sur des échantillons provenant de ces comtés, par le Dr. Charron.

Sont encore souvent magnésiens ou dolomitiques allant jusqu'aux magnésites, les calcaires cristallins ou marbres blancs de la formation dite de Grenville que l'on rencontre en beaucoup d'endroits de toute la partie du plateau Laurentian ou territoire se trouvant au nord de la rivière Ottawa, et comprenant, notamment, les régions du Nomininge, les vallées de la Lièvre et de la Gâtineau, dans les comtés d'Argenteuil, Labelle et Hull.

Preventions a L'Endroit des Calcaires Magnesiens

De la théorie de Loew, exposée plus haut, naquit assez naturellement, parmi les agronomes, une prévention à l'égard des calcaires magnésiens que l'on se plut à considérer, en beaucoup d'endroits, comme délétères pour les récoltes, en raison de la proportion trop élevée de magnésie qu'ils apporteraient aux sols amendés. Cette prévention s'est peut-être encore exagérée du fait bien connu que certains sels spécifiques du magnésium, tels que le chlorure de magnésium, qui accompagne plusieurs engrais potassiques bruts employés pour la fertilisation du sol, sont manifestement toxiques. Aussi a-t-on vu, jusqu'en ces dernière années, plusieurs autorités en sciences agricoles condamner l'emploi de chaux ou de calcaires magnésiens pour l'amendement des terres. Dans l'opinion de certains auteurs anglais, notamment, l'application d'amendements centenant un trop fort pourcentage de magnésie finirait par déprimer la formation du grain au bout de quelques années. Cependant, ainsi que le fait remarquer le Dr. W. Frear, dans le bulletin No. 261 du département de l'Agriculture de la Pennsylvanie, "si on admet qu'un certain equilibre entre la magnésie et la chaux, dans le sol, doit gouverner la croissance des plantes, il s'ensuivrait que dans les cas où le rapport entre les proportions de ces deux éléments nutritifs serait inconnu (ce qui est le cas général) il serait aussi risqué d'appliquer de la chaux pure que de la magnésie pure, et la pratique intermédiaire d'employer de la chaux ou du calcaire dolomitiques dans lesquels la chaux et la magnésie existent en proportions à peu près égales, se recommanderait après réflexion logique.

Cette Prevention Est-Elle Fondee ?

Examinons maintenant si, de fait, cette prévention qu'on a longtemps entretenue à l'égard des calcaires magnésiens est réellement fondée. On comprend facilement, en effet, l'intérêt pratique qu'aurait sa disparition pour la province de Québec en permettant l'utilisation des nombreux gisements de calcaires magnésiens dont nous avons parlé et dont on n'ose pas conseiller l'usage jusqu'ici. D'autant plus qu'à certains égards un calcaire magnésien, pour une même teneur en carbonates totaux, sera plutôt plus efficace qu'un calcaire ordinaire, attendu qu'à poids égal le carbonate de magnésie peut neutraliser une quantité d'accidité plus élevée que le carbonate de chaux, puisque le poids moléculaire de $Mg\ CO_3$=84 contre 100 pour celui de $CaCO_3$.

Or les conclusions des nombreuses recherches et expériences terminées au cours des dernières années semblent bien réhabiliter les chaux et calcaires magnésiens et mettre à néant les appréhensions pessimistes que suscitait leur emploi.

Ainsi dans la dernière édition, de l'année 1922, du traité amércain, bien connu, sur les sols intitulé: "THE NATURE AND PROPERTIES OF SOILS", par LYON et BUCKMAN, nous trouvons la conclusion suivante, formulée à la suite de l'exposé de la théorie de LOEW sur le rapport chaux-magnésie:

"La question se posa immédiatement de savoir si l'emploi de pierre à chaux ou de chaux vive et éteinte dans lesquelles la teneur en magnésie se rapprocherait à un certain degré de celle de la chaux pourrait être conseillée? De récents essais de laboratoires et en plein champ ont démontré cependant que des sels magnésiens peuvent être appliqués en quantités usuelles, isolément ou avec des composés calciques et cela impunément. Les propriétés absorbantes du sol semblement éliminer d'une façon très effective toute toxicité qui pourrait provenir d'une solution du sol physiologiquement non équilibré."

Opinions des Stations Agronomiques Aux Etats-Unis

Donnons aussi quelques opinions et résultats de recherches des principales Stations agronomiques des Etats-Unis, qui ont fourni les éléments des conclusions précitées:

Dans le bulletin No. 430 de la Station Expérimentale de Geneva, (Etat de New-York), année 1917, par J. F. Barker et W. W. Baer, nous trouvons à la page 26, sous le titre: "valeur comparative des calcaires pulvérisés", l'affirmation suivante:

"En autant que des études ont été faites sur le sujet, les calcaires magnésiens ont été trouvés tout à fait aussi efficaces que la pierre à chaux calcique, dans l'usage pratique de l'amélioration des sols. De fait un poids donné de carbonate de magnésium est capable de neutraliser un peu plus d'acidité que le même poids de carbonate de calcium, un poids de 100 lbs. du premier étant équivalent à 119 lbs. du second sous ce rapport. Il faut rappeler aussi d'ailleurs que le magnésium aussi bien que le calcium est un des éléments essentiels à la nutrition des plantes et qu'une partie de l'avantage de l'application de la pierre à chaux peut être du à l'apport plus abondant de ces deux éléments."

Dans le bulletin No. 11 de l'Université de Columbus, Ohio, il est répondu à question posée à la page 8.

Y a-t-il objection à l'empoi du calcaire magnésien?

"Pour autant que nous possédions des indications expérimentales en cette matière, il ne semble y avoir aucune raison pour laquelle nous condamnerions l'emploi de calcaire magnésien. Du carbonate de magnésium a été appliqué avec de bons résultats, à des terres acides, en quantitées beaucoup plus grandes qu'il ne le serait pratique de le faire dans des conditions d'exploitation d'une ferme."

Le bulletin No. 119 de la Station Expérimentale de l'Université de Tennessee, année 1917, par C. A. Mooers, sous le titre: "Valeur de la Dolomie", dit, à la page 199: "Cette station a fait quelques expériences en plein champ avec de la dolomie contenant environ 50% de carbonate de chaux contre 38% de carbonate de magnésie. Dans ces expériences, qui eurent lieu avec de la luzerne dans un sol manquant beaucoup de chaux, la dolomie donna des résultats entièrement aussi satisfaisants que du marbre purement calcique employé pour comparaison. Il n'y a donc pas de raison pour laquelle la dolomie ne devrait pas être recommandée."

Le bulletin 267 de la Station du New Jersey publie les résultats d'essais extensifs sur des parcelles dans le champ, qui démontrent que du calcaire magnésien donna des résultats un peu meilleurs que du calcaire ordinaire.

On pourrait objecter peut-être que les expériences faites aux diverses stations expérimentales des Etats-Unis ne portent que sur un petit nombre d'années et, qu'avant de se prononcer, il faudrait encore attendre et observer si l'emploi répété d'amendements magnésiens pendant plusieurs rotations successives ne finirait pas par exercer une action nocive sur le sol à la suite d'accumulation d'une trop forte quantité de magnésie dans celui-ci.

A cela on peut déjà répondre par les conclusions tirées des expériences de la Station de l'Illinois, commencées en 1902 et dont il est fait rapport jusqu'en 1918 dans le bulletin 212 de l'Université de l'Illinois, portant

par conséquent sur une durée de 16 ans. Or il y est dit que le calcaire dolomitique peut être employé avec succès sur les sols acides, qu'il est même légèrement plus efficace que le calcaire formé uniquement de carbonate de chaux pour la neutralization de l'acidité, étant plus durable et n'ayant pas d'effet nocif sur le rendement des récoltes.

Enfin notons encore que Lipman et Blair one publié dans "SOIL SCIENCE", en 1923 les résultats des expériences faites à la Station Exp. du New Jersey portant sur trois périodes d'assolement de cinq ans, soit 15 années, sous le titre: "A comparison of Magnésian and non magnésian limestone in some five year rotations."

Les auteurs en concluent que les dommages furent constatés lorsqu'on appliqua des quantités excessives de 4 tonnes de chaux magnésienne mais qu'en dehors de cela les deux formes de calcaire ont donné des résultats similaires, avec cependant une légère différence en faveur du calcaire magnésien.

CONCLUSION

En présence des résultats aussi unanimes obtenus par les stations expérimentales des Etats Unis, il nous semble bien que les craintes entretenues par rapport à l'action nocive des calcaires magnésiens sont vaines. On peut se demander, en effet, si la soit-disant action déprimante constatée par certains auteurs à la suite d'un emploi continu d'amendements magnésiens n'est pas tout simplement la conséquence ordinaire et bien connue d'un abus de la chaux sans restitution adéquate des éléments de fertilité, azote, acide phosphorique et potasse. D'autre part, comme le fait observer Burt, H. Hartwell, dans le Bulletin 186, du Rhode Island, année 1921, ceux qui onttenu en suspicion les amendements magnésiens, en raison du fameux rapport *chaux-magnésie*, ne semblent pas avoir considéré que dans certaines expériences en pots, faites à ce sujet, des quantités de pierre à chaux équivalentes à 60 tonnes à l'acre furent administrées en une seule application, chose qui évidemment n'est jamais réalisée dans la pratique.

Il serait donc pour le moins intéressant et utile de faire aussi dans la Province de Québec, des essais d'application de calcaires magnésiens pulvérisés dans les comtés où ces matériaux existent à l'exclusion des calcaires purement calciques.

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"*Leçons de chimie agricole*", par Raoul Cerighelli, docteur en sciences, ingénieur agronome, préparateur au Muséum l'histoire naturelle, volume de 362 pages, avec 66 figures dans le texte, prix 12 francs.

Ce manuel divisé en dix-huit leçons ou chapitres, comporte, outre le chapitre d'introduction qui traite de l'analyse élémentaire de la plante et des principales catégories des composés organiques qu'elle contient, quatre parties:

1o étude chimique de la plante;
2o étude chimique de l'atmosphère;
3o étude chimique du sol;
4o applications de le chimie agricole.

L'auteur, qui d'ailleurs ajoute au titre de son ouvrage la mention de cours élémentaire, n'a pas la prétention de nous exposer des choses nouvelles; la matière est extraite de divers ouvrages classiques du genre, de même que la plupart des figures, mais il doit son grand mérite à l'extrême clarté et simplicité de l'exposition. Aussi est-ce avec beaucoup de raison que monsieur Georges Wéry, directeur de l'Institut Agronomique de Paris dit dans la préface qu'il a écrite pour le volume: "L'auteur a constamment le souci d'être compris de tous. Il n'envisage que les problème que la science a déjà résolus, mais il sait les mettre exactement au point. En quelques trois cents pages, il offre aux élèves des écoles d'agriculture et aux cultivateurs un excellent résumé de nos connaissances actuelles en ces matières délicates." Remarquons que la quatrième partie de l'ouvrage, sous le titre de "Applications de la chimie agricole", comprend un chapitre consacré à la fertilité du sol, un autre aux amendements, et quatre au fumier et engrais chimiques. D'autre part, chaque leçon du manuel est suivie d'un tableau résumé, fort bien fait, qui permet de récapituler d'un coup d'oeil la matière étudiée. Aussi peut on dire que ce petit volume est très recommandable pour les conférenciers agricoles, les agronomes ou instituteurs s'occupant de cercles d'études. Ils y trouveront pour leurs leçons ou causeries des sujets presque entièrement préparés, dont la réunion des matériaux exigerait beaucoup plus de travail lorsque puisée dans des ouvrages plus élaborés mais plus diffus.

Le Docteur Amédée Marsan

Ingénieur agricole, premier docteur ès sciences agricoles de l'Université Laval, lauréat du Très-Grand Mérite Spécial en Agriculture.

Un monument à sa mémoire, à l'Assomption.

L'agriculture canadienne en général et, plus particulièrement, la Société des Ingénieurs agricoles, s'honorent de compter dans leur corps professionnel un apôtre et un savant de l'envergure du regretté Docteur Isidore-Joseph-Amédée Marsan.

Né à Saint-Roch de l'Achigan, le 19 juillet 1844, il fit ses études classiques au Collège de l'Assomption, une partie de ses études de droit à Montréal, et ses études agricoles à Sainte-Anne de la Pocatière. Il n'est donc rien d'étonnant que plusieurs institutions d'enseignement supérieur se réclament de le compter comme une de leurs gloires.

Vers 1867, sollicité par le Ministre de l'Agriculture du temps, il abandonna la carrière où il pouvait briller comme avocat, et se consacra entièrement à la mission qu'on voulait lui confier, pour le développement de la science agronomique dans la province de Québec. Bien peu d'hommes supérieurs étaient alors préparés à cette profession nouvelle et à ce rôle délicat. L'esprit d'apostolat, naturel à M. Marsan, la justesse de son jugement, ses talents reconnus et son amour infatigable de la science agricole en firent bientôt la lumière maîtresse de notre agriculture provinciale.

Le 11 mars 1868 il gradua comme ingénieur agricole devant la Chambre l'Agriculture du Bas-Canada et devint ex-officio membre de cette Chambre. En 1875, il était nommé conférencier officiel du Département de l'Agriculture de Québec. Depuis 1900 il a rempli, avec une exactitude et une science absolument inattaquables, la difficile charge de Secrétaire général de la Commission du Mérite Agricole. En 1903, il était nommé professeur et, en 1908, directeur scientifique de l'Institut Agricole d'Oka, affilié à l'Université de Montréal.

En reconnaissance de sa valeur et de ses innombrables services à l'agriculture canadienne, l'Université Laval le nommait, en 1914, doyen des Sciences agronomiques, avec le titre de Docteur ès Sciences agricoles. Puis, le Lieutenant-Gouverneur de la Province de Québec lui remettait, en 1921, en séance publique et solennelle, à Québec, le diplôme de Très-Grand Mérite spécial.

Comme tous les vrais savants, et comme tous les hommes de dévouement sincère et effectif, M. Marsan fut un modeste et un laborieux. Nous qui avons eu le privilège d'être de ses disciples, qui avons vécu durant quatre années dans l'intimité de son paternel professorat, nous gardons un souvenir inaltérable de sa bonté, de sa sollicitude, de son empressement auprès de chacun de ses élèves. Et si nous aimons le sol natal jusqu'à lui donner le meilleur de nos forces et de notre intelligence, c'est que l'auguste et vénéré docteur aimait avec passion cette vie agricole, et c'est qu'il nous en a révélé les secrètes puissances et l'immortelle beauté.

Que ce fût en classe, au laboratoire, dans les champs et les montagnes d'Oka, ou par toute la province agricole où nous le rejoignions, le Docteur Marsan restait pour nous le guide infaillible et le maître autorisé, dont les connaissances parfaites du sol et de la méthode culturale appropriée, furent pour chacun de nous la lumière et l'élan dans le travail d'apostolat et de technique à accomplir.

Aussi, à l'heure où il quittait sa tâche pour le repos qu'une longue et fructueuse vie lui a si largement mérité, à l'heure où nous réalisions que le vieux maître ne serait plus là, nous avons ressenti, en même temps qu'une profonde tristesse, un étrange regain de courage et de vaillance. Car nous nous sommes souvenus de ses leçons précieuses et de son exemple réconfortant. Nous avons retenu, dans la memoire fidèle de notre coeur, la douceur de son sourire et l'inaltérable vaillance de sa volonté. De même qu'il nous rappelait le prestigieux exemple des anciens dans l'accomplissement des tâches difficiles, de même aussi retrouvons-nous en lui le modèle le plus pur et le plus digne d'imita-

tion dans la réalisation des entreprises nécessaires qui nous ont été confiées.

La Société des Ingénieurs Agricoles remplit un devoir de justice et de gratitude en élevant un mausolée à la gloire du docteur Amédée Marsan, sur le sol même où il fonda l'une des premières écoles d'agriculture en cette province. Les autorités les plus hautes, du gouvernement, des universités et des collèges agricoles, les dirigeants du collège de l'Assomption, les sociétés agricoles de toutes catégories, les ingénieurs de la profession agronomique, s'unissent dans un même mouvement de généreuse reconnaissance pour assurer à ce bienfaiteur du terroir canadien une place lumineuse et fleurie au soleil de nos champs, désormais généreux et prospères, et qu'il a tant aimés.

ALPHONSE DESILETS,
Ingénieur agricole,
Membre du Comité du monument.

NOUVELLES DE NOS ECOLES D'AGRICULTURE

Le concours de préparation et d'appréciation des animaux, organisé par le Professeur Gustave Toupin, sous la présidence d'honneur du Très Rév. Père Abbé, a eu lieu le 20 mai dernier. Le succès de ce genre de démonstration, inauguré il y a trois ans, va toujours grandissant. Cette fois environ trois cents spectateurs, venus non seulement des alentours, mais encore de comtés fort éloignés, emplissaient le pavillon d'appréciation devenu trop petit pour la circonstance. Même pour un profane en industrie animale, la grande utilité, pour les élèves, d'un pareil entrainement saute aux yeux. Il est facile de se compte, en effet, qu'ils conserveront pour toujours une profonde impression de ce qui fait les qualités ou les défauts d'un animal, après cet exercice d'observation et de préparation des sujets, pratiqué durant plusieurs semaines et couronné par l'épreuve finale à laquelle une assistance nombreuse et intéressé ajoute sa part de stimulant. Aussi peut-on se demander parfois si un même genre d'entrainement ne pourrait pas s'appliquer avec avantage à d'autres branches de l'enseignement agricole.

L'organisation des nouveaux laboratoires a amené la nomination d'un assistant-professeur de chimie. Le titulaire en sera Monsieur Albert Leduc, B.S.A., de la promotion de 1924. M.-A. Leduc qui avait fait un brillant cours à l'Institut Agricole d'Oka s'est spécialisé dans l'étude de la chimie analytique, à Cornell durant l'été de 1924, et au collège Macdonald depuis le mois de septembre dernier. M. Leduc a préparé une thèse sur l'analyse des corps gras, et plus spécialement des beurres qu'il présente pour l'obtention du degré de Maître ès-Sciences (M.S.).

BIBLIOGRAPHIE

Une nouvelle Revue Canadienne francaise "L'actualité économique"

Organe officiel de l'Association des licenciés de l'Ecole des Hautes Etudes Commerciales, de Montréal.

Prix de l'abonnement $2.00 par an.

Rédaction et administration, 399, Avenue Viger, Montréal.

Le mois d'avril a vu paraître le premier numéro de cette nouvelle publication mensuelle, dont le comité de rédaction est entièrement composé de diplomés de l'Ecole des Hautes Etudes commerciales de Montréal.

Les articles substanciels de cette primeur, couvrant 34 pages d'un texte serré, font bien augurer de l'avenir de la revue. Ils constituent un vigoureux témoignage de l'excellente formation que reçoivent les jeunes gens à notre Institut supérieur de commerce.

Nul doute que les jeunes compétences qui se révèlent ainsi sont appelées à faire beaucoup pour le progrès de la race canadienne française dans la voie de l'emprise économique, et celà en dépit de certains pessimistes qui pensent toujours qu'il est trop tôt pour aller de l'avant.

Pour les agronomes aussi, que rien de ce qui touche les problèmes économiques du pays ne devrait laisser indifférents, "L'Actualité Economique" est une publication pleine d'intérêt.

Notons d'ailleurs, parmi les articles, une étude sur le commerce et la culture du blé au Canada, signé de deux confrères: M.-M. Georges Bouchard et Charles Gagné, l'un et l'autre professeurs à l'Ecole d'Agriculture de Ste. Anne de la Pocatière.

Nos meilleurs voeux de succès et de longue vie vont à l'Actualité Economique.

H. M. N.

C. S. T. A. Forum

This section has been introduced in *Scientific Agriculture* in order to publish communications from C.S.T.A. members dealing with matters of professional interest, and also for the publication of subsequent discussion of such matters. It is hoped that members will take full advantage of the opportunity thus offered of bringing their views to the attention of the profession, and in this way promoting interesting and helpful discussion. The names of correspondents will be omitted if desired, but must always be furnished to the General Secretary.

ONE CONCRETE EXAMPLE OF GOOD PROMOTION WORK

In 1921, whilst idly strolling through the buildings of the Calgary Exhibition, I watched an interested crowd gathered around a representative of the Dominion Government who was explaining the difference between purebred birds and poultry that were "just hens." At this moment, I did not know a Wyandotte from a Cochin-China and we were keeping "just hens."

Some conversation with this well-informed representative led to an appointment on my farm, which eventually resulted in my establishing a modern poultry house, the foundation of a flock of purebred Barred Plymouth Rocks, and the entry of these birds into the Dominion Record of Performance test. I was more or less wet nursed by the poultry promotor of Alberta until things were running smoothly.

My neighbours then became frequent visitors and took much interest in this up-to-date arrangement for poultry housing and management.

Today, after four years have elapsed, within a few miles of this farm no less than ten of my neighbours have erected similar, if not better, houses, have stocked themselves with purebred poultry in flocks varying from three hundred to one thousand birds, and have made a good deal of money by devoting themselves to the production of winter eggs. Most of these people, moreover, have contracted directly with retail merchants in Edmonton and Calgary and have enjoyed almost the retail price for their eggs. This has meant a very handsome winter revenue to this district, and practically all due to the fact that the Dominion Government took an interest and actually helped me to establish on this farm a complete plant for winter laying poultry.

The majority of these people have only incidentally seen the Government representatives after they were established.

Branching out from each of the farmers that copied my own plant, will undoubtedly, if this has not already occurred, start more and more waves of interest in this same work, which will certainly also result in more and better poultry being kept, housed and managed.

I suppose that in this district the same number of poultry lectures and the same amount of poultry literature have been given to these farmers as has been usual in the last ten years in most districts, but it was not until an actual plant was started that any development took place.

I have tried to make myself familiar with the different forms of promotion work, and of help and assistance that have been offered to the farmer in various branches of agriculture. I have noted the advice which is being scattered broadcast by Government officials to keep better bred cows, to feed the cows a balanced ration; to keep the bacon hog, and to manage the hog in a better fashion; to grow more alfalfa; to clean our grains and to keep and feed the screenings at home; to keep some winter feeders and to use up some of our grain for feeding; a flock of sheep for every farm; plant trees and currant bushes around the house, etc., etc., etc.

While undoubtedly much of this bears fruit, I sometimes wonder if quicker and better results might not be obtained if the illustrative method were not more adopted—such as I have described in connection with poultry.

My own way of reasoning is something like this: If it is economically better to feed cows a balanced ration, then pick some intelligent farmer, induce him to carry out definite instructions, and as soon as his milk pails become more full than usual, the news will spread like wild-fire to his neighbours.

If bacon hogs are better than thick smooths, and if proper management and housing and feeding will increase hog profits, get some farmer to do it—to carry out the exact plans in mind—and so on and so forth with alfalfa, or sweet clover, the feeding of winter cattle, the finishing of animals, etc., etc. My own experience of the Western farmer is that he is loath to be put in the position of one who is given definite advice, as it implies, in his eyes, that he is not as capable in farming as he should be. He is, however, an inveterate copyist of good things, and if allowed to pick up better methods in his own way and in his own time, will invariably do so if the example is set, and apparently it should be the aim of our technical agriculturists, whose work this is, to scatter skillfully in his path those ideas which he can pick up and think are more or less his own.

An amusing incident occurred at our local post office the other day. One of my neighbours, who is making a very good living in growing a recently selected strain of Marquis Wheat—selected by the University of Alberta—; a similar strain of Victory oats; some fine O.A.C. barley from the Ontario Agricultural College; who is keeping some eight hundred winter laying Leghorns secured from a British Columbia breeder; who obtains R.O.P. cockerels each year from the University of British Columbia; who houses his flock in an up-to-date Ottawa Experimental Farm house; feeds and manages them by methods originated and broadcasted by the various Experimental Farms throughout the country,—said to the crowd:

"I'll tell you, fellows, that this money we tax-payers give to these Experimental Farms is wasted. They never did a thing for *me*. I know that!"

It is, of course, to laugh! I guess, however, that you technical agriculturists do not very much care about this attitude of mind so long as this man is enjoying a better farm living through your efforts.

"Dirt Farmer".

ON ADVERTISING

During the past few years I have had occasion more than once to bring the advertising value of our official organ to the attention of manufacturers, and have later seen their advertisements in the magazine. It has often occurred to me that if other members, who have similar opportunities, would use their professional connections in this way, it would not be long until many firms who are not now supporting the magazine would be including it in their lists of advertising mediums.

I have not given the question of advertising very much attention, but I know that the financial success of the C.S.T.A., and the amount required in annual fees, depend almost entirely upon our advertising revenue. It seems to me, therefore, that members ought to be able to assist materially in this part of our activities. Those who are engaged in scientific work must have personal contact with many firms handling laboratory equipment, chemicals, etc., many of our members are in close touch with manufacturers of farm implements; new developments in almost all branches of agricultural manufacture come to the notice of C.S.T.A. members, and these members should encourage the announcement of these developments in the advertising pages of *Scientific Agriculture*. The member who wants to know how he can help the Society, can probably give very definite service in the manner I have suggested.

I should like to have the opinions of other members on this subject, and believe if we would work together we could soon double our advertising revenue and at the same time bring about a closer contact between C.S.T.A. members and manufacturers.

"A Society Booster."

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

The following have been admitted as regular members of the Society since June 1, 1925:

Albright, W. D., Supt., Experimental Station, Beaverlodge, Alta.

Bonnier, M. B. (Montreal, 1922, B.S.A.) Ste. Therèse, P.Q.

Bordeleau, R. (Montreal, 1924, B.S.A.) Ste. Thècle, P.Q.

Buckingham, E. H. (Alberta, 1921, B.S.A.) Dominion Seed Branch, Calgary, Alta.

Bois, H. C. (Laval, 1917, 1921, B.A., B.S.A.) Agricultural Institute, Oka, P.Q.

Bowstead, J. E. (Wisconsin, 1920, 1921, B.Sc.; M.Sc.) University of Alberta, Edmonton, Alta.

Bark, D. H. (Valparaiso, 1901, B.S.) Brooks, Alta.

Bate, H. K. (McGill, 1922, B.S.A.) Black Lands, N.B.

Clarke, A. E. (Alberta, 1924, B.S.A.) University of Alberta, Edmonton, Alta.

Gingras, P. (Montreal, 1921, B.S.A.) Huntingdon, P.Q.

Gagnon, M. J. (Laval, 1922, B.S.A.) Rimouski, P.Q.

Gentleman, W. D. (Alberta, B.S.A.) Tees, Alta.

Hay, W. D. (McGill, 1920, B.S.A.) Exp. Station, Lethbridge, Alta.

Hutt, F. B. (Toronto, 1923, B.S.A.; Wisconsin, 1925, M.S.), Agricultural College, Winnipeg, Man.

Martin, W. M. (Alberta, 1924, B.S.A.) University of Alberta, Edmonton, Alta.

Newman, A. (Manitoba, 1924, B.S.A.) Exp. Station, Lethbridge, Alta.

Newcombe, F. H. (Manitoba, 1924, B.S.A.) Vegreville, Alta.

Robichaud, J. A. (Laval, 1922, B.S.A.) Princeville, P.Q.

Snelson, W. H., Irrigation Specialist, C.P.R., Brooks, Alta.

Strange, H. G. L., Fenn, Alta.

St. Pierre, A. (Laval, 1922, B.S.A.) Quebec, P.Q.

NOTES

P. M. Simmonds (Macdonald '21) has been appointed in charge of the Dominion Plant Pathological Laboratory at Indian Head, Sask. He has just completed a year's graduate work at the University of Wisconsin.

D. B. Shutt (O.A.C. '22) has been appointed Associate Professor of Bacteriology at the Ontario Agricultural College, and assumed his new duties on July 1st.

H. Barton (O.A.C. '07), who has been Professor of Animal Husbandry at Macdonald College since 1909, has just been appointed Dean of the Faculty of Agriculture (Macdonald College) of McGill University. Further details of this appointment will be found on page 390.

A. Fulton (O.A.C. '21) was recently promoted from Assistant to the Fruit Commissioner to Chief of the Markets Division in the Dominion Fruit Branch.

FIVE VOLUMES

The present issue concludes the fifth volume of *Scientific Agriculture*. The first volume, containing only six numbers, was published by the Industrial and Educational Publishing Company, and the last four volumes, of twelve numbers each, have been entirely under Society ownership.

Few members realize the amount of material required for fifty numbers of this magazine. An index covering the entire period would be impressive. Over two hundred articles have appeared in *Scientific Agriculture*, covering every phase of agriculture in a space of nearly two thousand pages. What would have become of these articles if *Scientific Agriculture* had not been in the field? How many would have reached our members?

Those who are inclined to question the usefulness of the C.S.T.A. might well consider some of its activities in a fairer light, before deciding as to the need for such a body.

VISIT TO E. P. RANCH

Those who were privileged to attend the outing at the Prince of Wales' ranch on June 27th, will be specially interested in the group of photographs on the opposite page. These pictures were taken by Mr. Cecil Tice of the Department of Agriculture, Victoria, B.C. Anyone who wishes original copies of any of the snapshots—all of which are postcard size—can obtain them at cost by writing direct to Mr. Tice.

MEMBERSHIP CAMPAIGN

The General Secretary is now organizing a membership campaign, to be launched about September 15th. The present membership is 765 and it is hoped that this number can be increased to 1,000 before the Ottawa Convention next year. The special offer which is being extended to non-members, to join for $6.00, expires on Dec. 31st of this year, when an additional initiation fee of $5.00 becomes effective.

Members can assist materially in the coming campaign by forwarding to the General Secretary the names and addresses of any eligible members in their locality or elsewhere.

BUREAU OF EMPLOYMENT

As a result of a resolution passed at the Edmonton Convention, it is necessary that steps be taken to re-organize the former Bureau of Records, and to put into effective operation a Bureau of Employment. This re-organization will occupy the major part of the winter months and it is hoped that the new Bureau will become active about March 1st, 1926. All members will be asked to assist in preparing a complete record of the professional experience, academic training, etc., of society members, and when this has been completed the co-operation of all employing agencies will be solicited.

NEW LOCALS

At a small meeting held at Port Arthur, Ontario, on June 16th, a new branch of the C.S.T.A. was organized and officers elected. It will be known as the North-Western Ontario Branch.

It is expected that another new local will be organized at Ste. Anne de la Pocatière in August.

The addition of these two locals will bring the total number of C.S.T.A. branches in Canada to fifteen.

DISTRICT REPRESENTATIVES ENTERTAINED

On the occasion of the annual meeting of the District Representatives of Ontario, the Eastern Ontario branch of the C.S.T.A. provided a reception in the Parliamentary Restaurant of the House of Commons at Ottawa, on June 26. Mr. Geo. Bouchard, M.P., for Kamouraska County, P.Q., presided and introduced the Honourable Mackenzie King, Prime Minister of Canada, who addressed the gathering. About one hundred were in attendance.

N. S. LOCAL

The summer meeting of the Nova Scotia local is being held on August 5th. The programme includes a visit to the Experimental Farm at Kentville, inspection of orchard experiments at Gaspereau and Port Williams, a tour of the Gaspereau Valley, a study of the manufacture of insecticides and fungicides at the plant of the Eastern Lime Company, Windsor, and a dinner at the Cornwallis Inn at Kentville. These summer meetings have been very successful in the Maritime provinces and might be adopted to advantage by other branches of the Society.

KEY TO E. P. RANCH GROUP

1. Prof. W. L. Carlyle, Manager of E. P. Ranch.
2. The Ranch House.
3. Some of those attending the outing.
4. Dean E. A. Howes, President of the C.S.T.A.
5. Officers of the C.S.T.A. and Prof. Carlyle. The names left to right are: F. H. Grindley; H. Barton; E. A. Howes; W. L. Carlyle; G. M. Stewart, Calgary; P. E. Reed, Regina.
6. Prof. Carlyle and the Prince's shorthorn bull, "King of the Fairies."
7. The Ranch Stables and Silo.

C.S.T.A.
Visit to
E·P·
RANCH
JUNE 27th
1925

New Dean for McGill Faculty of Agriculture.

Professor Barton's Appointment

Professor Horace Barton, newly appointed Dean of the Faculty of Agriculture, (Macdonald College) McGill University, comes to his new duties with an established reputation for ability in his chosen profession, for geniality in his social activities, for leadership in a sphere that includes something more than his local district, or even province, and, above all, for good judgment. This latter trait, I believe, more than any other has made Professor Barton what he is to-day—a man universally liked and respected by both scientists and farmers, and one whose presence is much sought after in judging ring and council hall. For his good judgment has made him a man who is dependable, whether it be in the field or in the conference, in the stock yards or on the golf course; those who best know him know that he can be counted upon to consider well before making his play, and that, having considered, he will move swiftly and surely without needless show.

Professor Barton's birthplace and training have been in his favor, in giving him the ground work for leadership in agriculture. Born, in 1883, at Vankleek Hill in Eastern Ontario, the son of a leading farmer of that district, and on a farm on which live stock was featured, he laid the foundation for his success in Canadian agricultural work in the right place. And this practical work of his youth was never allowed to be lost, for when, after his schooling in the public and high school had been completed, he proceeded to the Ontario Agricultural College, it was to take first two years work at that seat of science, then three years work on his home farm, and then his last two years work leading to graduation in the science of Agriculture.

This close association of the practice of agriculture with the scientific side of it has, perhaps more than any other thing, given Professor Barton an enviable reputation with students and farmers alike, who have come to look upon him as one who speaks "with authority". And it is not too much to say that in Macdonald College, where for eighteen years Professor Barton has been attached to the Animal Husbandry Department, for two years as lecturer, and since 1911 as professor and head of the department, and in the Province of Quebec as a whole, there is no more popular lecturer or live stock judge than he.

Professor Barton's work in judging circles dates from the days of his college course at Guelph, when in 1907 he was a member of the O.A.C. team of live stock judges that won for their college the coveted judging trophy offered by the Chicago Live Stock Exposition; and it is interesting to note that just four years later a Macdonald College team, trained by Prof. Barton, carried off the same trophy for the Quebec College. And in the course of his occupation of the professorship of Animal Husbandry at Macdonald College, Professor Barton has acted as judge at practically every one of the leading live stock shows in Canada, at many of the important events across the border and was the first judge from any other country to place the ribbons in Scotland.

Of his record as a teacher it is only necessary to state that of the students graduating at Macdonald College since its inception thirty-five percent have specialized in Animal Husbandry and all have taken their work under Prof. Barton. Of his popularity with practical farmers evidence may be seen in his great demand as a speaker at agricultural conventions of every kind, in the fact that he has had much to do with the establishment of such organizations as the Milk Producers Association of Montreal and The Advanced Registration for Dairy Cattle in Canada and in his work as chairman of the Soldiers' Settlement Board of Montreal. Of his standing with the scientists of the profession one need only mention that Professor Barton after a second term of office is the retiring President of the Canadian Society of Technical Agriculturists and this organization, it will be recalled, in its membership of 800 counts practically all of the teachers and research workers in agriculture in Canada.

—S.R.N.H.

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Dominion Department of Agriculture Notes.

ENTOMOLOGICAL BRANCH

Mr. Arthur Gibson, Dominion Entomologist, represented the Department of Agriculture at the Second Imperial Entomological Conference held in London, England, June 8 to 18.

The Conference was attended by entomologists from practically all of the colonies and dominions within the Empire. Methods of organization, control methods, etc., were discussed and much information of value disseminated to all of the delegates.

Mr. Gibson gave an account of the Canadian Entomological Service and showed a moving picture film of the European corn borer and its work in Ontario. While in England visits were also paid to the Entomological Departments of Oxford, Cambridge, Cheshunt, Wisley, etc., and several of the larger nurseries.

The Entomological Branch has published recently a pamphlet entitled "Methods of Protection from Mosquitoes, Black-flies and Similar Pests in the Forest". This is an interesting pamphlet and should have a wide distribution among campers, foresters, and others who have to go into the woods.

At the recent meeting of the Royal Society of Canada, Mr. Gibson presented the following papers:

"Observations on the Spruce Budworm, *Cacoecia fumiferana* Clem." by himself.

"The Ephemeroptera of Covey Hill, Que." by J. H. McDunnough.

"Revision of the American Species of the Tachinid Genus *Peleteria* (Diptera)". By C. H. Curran.

"A Preliminary Revision of some Charopsinae, a sub-family of Ichneumonoidea or Ichneumon Flies". By H. L. Viereck.

LIVE STOCK BRANCH

Mr. Ernest Rhoades, Assistant Chief of the Poultry Division, has been appointed Secretary of the World's Poultry Congress which is to be held in Ottawa in 1927. Mr. S. C. Barry, who has been employed as a Poultry Inspector in the Province of British Columbia since January last, is being transferred to Ottawa to take over the duties of Assistant Chief of the Poultry Division during Mr. Rhoades' absence.

Mr. Charles F. MacKenzie of Port Stanley, Ontario, was permanently appointed as a District Live Stock Promoter, province of Ontario, on July 6th.

Mr. John Arthur Steele of Almonte, Ontario, was temporarily appointed as a District Live Stock Promoter, Western Ontario, on July 6th.

Sheep & Swine Division

The Ram Premium Policy has been revised. The new feature of the policy is that bonuses will be paid only on purebred rams purchased by members of a club of not less than ten sheep raisers, each of whom has not less than ten ewes and who uses a purebred ram for the first time.

The installation of permanent sheep dipping tanks is meeting with great favour. The bulk of this work is being done in Ontario and excellent results have already been noted. Wool graders report a decided improvement in the wool received from districts where this work has been done.

Extra work in connection with bacon hog production and marketing is being carried on in Western Canada this summer, particularly in Alberta.

Considerable interest is being taken in the inter-county competitions of bacon hogs and market lambs which will be held at both the Central Canada Exhibition at Ottawa and at Canada's Great Eastern Exhibition at Sherbrooke.

Cattle Division

Advanced Registration for Dairy Bulls

Advanced registration for dairy bulls was inaugurated on May 1st by the Dairy Cattle Committee with the following breed associations contributing to the support of the plan: Ayrshire, Jersey, French Canadian, Guernsey and Red Polled. Up to July 15th Mr. William Hunter, senior inspector, had passed on 75 bulls out of a total of 178 for which applications had then been received. As was anticipated, this year's inspections will include many herd sires now in use. Only a moderate percentage of these sires have been found

to have the necessary credentials for better than class "A" registration, however.

As most of the 1924 crop of bulls were sold before the work was commenced the number of young bulls submitted to date has been confined chifly to the more outstanding individuals with the result that the percentage of rejects has so far been very small. During the fall it is expected that an increasing number of young bulls will be entered by breeders each month as the late 1924 calves and the Spring calves of 1923 will by that time be eligible for inspection and breeders will have had an opportunity to become conversant with the importance of securing this recognition for their young bulls which are coming to marketable age.

Feeder Purchase Policy

In order to encourage the winter feeding of cattle and of lambs in Western Canada and incidentally to insure the success of the Feeder Shows which will be held at Winnipeg, Moose Jaw and Calgary this fall, the Honourable Mr. Motherwell has authorized the Dominion Live Stock Branch to put into operation for a period of three months a Feeder Purchase Policy which will be similar in effect to the Car Lot Policy which was discontinued in April last. Under this policy, the Live Stock Branch will pay reasonable travelling expenses of a farmer residing in Western Canada or of the authorized agent of farmers residing in Western Canada who purchases one or more car loads of feeder or stocker cattle, or of feeder lambs, at his nearest Stock Yards, to be returned for finishing purposes to his own farm or to the farms of those for whom he has acted as agent.

To facilitate the attendance of farmers from Eastern Canada at the Feeder Shows, and in order to provide a further opportunity for them to perfect a direct contact with western ranchers for the securing of their annual supply of feeder cattle and feeder lambs, the Minister has also authorized the Live Stock Branch to put into effect a three months' Policy on lines similar to the assistance given in the Fall of 1924. Under this policy the Branch will pay the one-way travelling expenses to Winnipeg, Moose Jaw or Calgary of an Eastern applicant who purchases one or more car loads of feeder steers or lambs at one of the Feeder Shows, or who purchases a car load or more of steers direct from the range area. Both of these policies become effective on September 1st.

SEED BRANCH

A New Grass Industry

Native Maritime Browntop yielded more than fifty dollars per acre to some farmers near Souris, P.E.I., during the last year. Nearly four thousand pounds of the seed from this native grass, commonly regarded as a filler in meadows, was harvested, threshed, cleaned by the farmers themselves, graded No. 1 and sealed in the sack by Seed Inspector Gordon Macmillan, of North River, P.E.I., and promptly sold at seventy-five cents per pound.

There are many thousands of acres of this native browntop growing on old pasture areas in Nova Scotia, New Brunswick and Prince Edward Island. Throughout North America the seed is known in commerce as Rhode Island Bent Grass. The same species when harvested in Europe is marketed under the name Mixed German Bent. About sixty-five years ago fishermen from Prince Edward Island and Pictou, Nova Scotia, built ships and went to New Zealand. Their mattresses were made up of this native grass, and where emptied in New Zealand the grass got a start. Now the seed is coming back under the name Colonial Bent.

This is the same species of grass that makes Ireland and England perpetually green. It is probably the most desirable species of grass that is commonly propagated from seed for use on lawns and golf courses, and the demand for the seed is very large. Instead of producing four thousand pounds the three Maritime Provinces ought to be producing four hundred thousand pounds of this seed. The price of seventy-five cents per pound for seed that is graded No. 1 under the Seeds Act, and from fields that have been inspected and certified to be ninety per cent or more true to the species *Agrostis tenuis*, is not apt to be very much reduced unless and until the world supply is very much larger than it has been during the last twelve years.

A special service of inspection and certification of the fields and later assistance with the grading and cleaning of the seed for commerce is provided by the Seed Branch under the direction of Mr. Garnet LeLacheur of the Ottawa staff. Mr. LeLacheur is now in the Maritime Provinces and reports that the 1925 crop is expected to double that of last year.